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A Comprehensive Analysis of Navy and Marine Corps Digital Mapping, Charting, and Geodesy Requirements for Modeling and Simulation

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<p>The Naval Research Laboratory conducted an extensive in-person survey of the Navy and Marine Corps modeling and simulation (M&S) community's digital Mapping, Charting, and Geodesy (dMC&G) and value-added data requirements during late 1992 and early 1993. Simultaneously, the Air Force, the Army, and the National Security Agency (NSA) conducted similar studies for their respective services/agencies.</p> <p>Over 100 programs responded to this Navy study. This report presents an analysis of the collected requirements and emphasizes identifying feature, attribute, and value-added information that the M&S community requires but that is currently not available. Attention is given to required modifications to existing DMA dMC&G products. This report seeks to identify modifications to emerging and existing DMA products needed for optimum use by the Navy M&S community, and focuses only on the changes and improvements.</p>			
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EXECUTIVE SUMMARY

The Naval Research Laboratory conducted an extensive in-person survey of the Navy and Marine Corps modeling and simulation (M&S) community's digital Mapping, Charting, and Geodesy (dMC&G) and value-added data requirements during late 1992 and early 1993. Simultaneously, the Air Force, the Army, and the National Security Agency (NSA) conducted similar studies for their respective services/agencies. This effort was sponsored by the Defense Modeling and Simulation Office, with the Defense Mapping Agency (DMA) as the program manager and integrator of the service/agency requirements. Over 100 programs responded to this Navy study.

This report presents an analysis of the collected requirements and emphasizes identifying feature, attribute, and value-added information that the M&S community requires that is currently not available. These findings are shown in Sec. 2.0. Attention is given to required modifications to existing DMA dMC&G products shown at the end of Sec. 4.0. This report seeks to identify modifications to emerging and existing DMA products needed for optimum use by the Navy M&S community; therefore, the report focuses only on the changes and improvements. Key findings and recommendations of this report are as follows:

FINDINGS

- A prototype value-added layer of Oceanographic and Atmospheric Master Library model output and databases in vector product format (VPF) coverage format needs to be produced which will combine the standard oceanographic model output and databases with emerging dMC&G vector products for improved exploitation.
- The M&S community has specific feature, attribute, and value-added requirements that are not met (specified in Sec. 2.0).
- The M&S community identified several modifications and errors with multiple DMA dMC&G products (specified at the end of Sec. 4.0).
- There is a strong requirement for a standard set of algorithms to convert appropriate DMA two-dimensional databases to three-dimensional databases.
- Currently, 9 programs use World Geodetic Survey (WGS) 72 and 5 plan to use WGS72 in the future instead of WGS84.
- Key feature classes were elevation, hydrography, and boundaries.
- Most commonly required currentness range is less than 3 years.
- Most common horizontal and vertical absolute accuracy will remain 5 m.
- Current vertical and horizontal relative accuracy requirement is 5 to 10 m. The future requirement is 0.5 to 10 m.

- Most users will require 1-m horizontal and vertical resolution in the future.
- Large increases in future requirements are seen for the feature classes of transportation, vegetation, hydrography, industry, and utility. Most feature-class requirements will double in the future.
- Responses indicate that 24 programs use and will continue to use 100% DMA products.
- Of the 110 programs responding, 47 use some non-DMA products.
- Requirements will more than double for the following products:
 - Digital Terrain Elevation Data (DTED II)
 - Digital Feature Analysis Data (DFAD I)
 - DFAD III
 - Interim Terrain Data (ITD)
 - Tactical Terrain Data (TTD)
 - Digital Chart of the World (DCW)
 - Compressed Aeronautical Chart (CAC)
 - Digital Bathymetry Database (DBDB) 0.5
 - DBDB 0.1
 - Probabilistic Vertical Obstruction Data (PVOD)
 - Terrain Contour Mapping (TERCOM)
 - Digital Point Positioning Database (DPPDB)
 - Digital Gazetteer.
- Of the 62 programs that use DMA products, 47 programs require preprocessing before use.
- M&S programs, in general, are not aware that classified as well as commercial imagery should be obtained via DMA.
- Currently, 21 programs use proprietary dMC&G data, but only 4 anticipate doing so in the future.
- DTED and World Vector Shoreline (WVS) were the most frequently noted existing products that do not meet Navy M&S requirements. Errors were the major problem with DTED, while resolution and near-shore zone problems were frequently mentioned for WVS. DFAD and DPPDB (interim) followed in the number of complaints received about products. Lack of features for DFAD and accuracy for DPPDB (interim) were the most frequently referenced shortcomings.
- Ten programs noted that it took too long to obtain DMA dMC&G data (emphasis on digital); 17 programs were not aware of available DMA products.

RECOMMENDATIONS

- Produce a prototype vector database for the M&S community that includes the required features and attributes (Sec. 2.0). Area of coverage should be the Norfolk littoral warfare test area and distribution should be via compact disk-read only memory (CD-ROM).
- Include the value-added feature/attribute information on infrared and night-vision goggle signatures of key features and targets (to be identified, if approved, by the Naval Training Systems Center) in the recommended prototype.

- Perform a detailed analysis to alleviate the overlapping feature classes, features, and attributes that currently exist among Vector Smart Map (VMap), ITD, Urban VMap (UVMAP), Digital Nautical Chart (DNC), WVS, DCW, DFAD and DTED II. If overlap is not alleviated, guidance must be given to the users for proper/optimum usage of the correct product for a given feature class, feature, or attribute.
- Provide a standard symbology set for all emergent DMA vector products, such as DNC, ITD, VMap, and UVMAP. The symbology set must be an integral and required part of each emerging vector product specification.
- Correct the deficiencies/errors noted regarding several DMA products shown at the end of Sec. 4.0 of this report.
- Develop a standard set of algorithms to convert appropriate existing DMA two-dimensional databases to three-dimensional.
- Incorporate the accuracy and resolution requirements specified in Sec. 3.0 into the emerging vector products DNC, VMap, UVMAP, and ITD.
- Improve the mechanics and speed of obtaining dMC&G products (emphasis on digital, not hardcopy maps) from the Combat Support Center.
- Produce a sampler CD-ROM with an updated “Digitizing the Future,” as well as an expanded MC&G Utility Software Environment (MUSE) software for all DMA current and prototype vector products.
- Publicize the fact that all imagery (classified and commercially available) should be obtained through DMA.
- Develop and maintain a listing and brief description of all current and emergent DMA and Naval Oceanographic Office products.
- Integrate Master Seafloor Digital Database requirements into emerging shallow-water products.
- Publish a DMA or Navy newsletter for emerging DMA products.
- Require that Navy M&S programs use WGS84 as their horizontal datum.

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A COMPREHENSIVE ANALYSIS OF NAVY AND MARINE CORPS DIGITAL MAPPING, CHARTING, AND GEODESY REQUIREMENTS FOR MODELING AND SIMULATION

1.0 INTRODUCTION

In October 1990, Congress authorized and established the Defense Modeling and Simulation Office (DMSO) in response to several studies that demonstrated the possibility of significant military benefits from the implementation of standards for Joint Services modeling, simulation, and information sharing. During October 1991, DMSO opened competition for projects to meet these goals. As one of the 20 projects funded for CY92-93, DMA was chosen to investigate and establish Terrain Requirements and Standards. In establishing these requirements, one of DMA's first objectives was to survey the M&S community using a questionnaire defined jointly by DMA and the services to assess the magnitude, location, accuracy, and content of the dMC&G requirements. As part of this survey, NRL was requested to collect and define the dMC&G and value-added (data that has not historically been provided by DMA) data required by the Navy and Marine Corps for M&S. DMA will then integrate the results of this survey with similar results from the other services and NSA into an overall Terrain Requirements and Standards for the DMSO.

The purpose of this report is three-fold. The first is to identify the dMC&G requirements of the Navy and Marine Corp M&S community, and the need for value-added cartographic data. The second is to review the requirements information, and the third is to make specific recommendations to N096 and DMA to better meet the needs of the M&S community.

This study sought to optimize existing and emerging DMA products for the M&S community. Therefore, the aim of the report is to suggest improvements to both DMA products and value-added data.

1.1 Acronyms

The MC&G community deals in its own set of acronyms, which can often become confusing. As an aid to the reader, Table 1 defines the acronyms used in this report. They are not redefined in the text.

1.2 Definitions

The following definitions are the authors' and are intended for use in the context of this document.

Table 1 — Acronyms

AAA	Anti-Aircraft Artillery
AAM	Anti-Aircraft Missile
ACAAM	Air Courses of Action Assessment Model
ACDS	Advanced Combat Direction System
ACM	Air Combat Maneuvers
ADCP	Acoustic Doppler Current Profile
ADRG	ARC Digitized Raster Graphics
ADS	Advanced Deployable Systems
ADM	Advanced Development Methods
AEAS	Advanced Environmental Acoustic Support System
AEFWC	No definition available
AMC	Adaptive Mission Control
APL	Applied Physics Laboratory
AQUARIUS	Navy System
ARC	Equal Arc Second Raster Chart/Map
ASW	Anti-Submarine Warfare
ATR	Automatic Target Recognition
AVHRR	Advanced Very High Resolution Radiometer
AWOIS	No definition available
AWSIM	Advanced Weapon System Information Management
AWTT	Amphibious Warfare Tactical Trainer
BBS/DIS	Bulletin Board System/Distributed Interactive Simulation
BFTT	Battle Force Tactical Trainer
BUDS	Basic Underwater Demolition School
C ⁴ I	Command, Control, Communications and Computers Intelligence
CAAM	Composite Area Analysis Model
CAC	Compressed Aeronautical Chart
CAD2	Computer Aided Design 2
CADB	No definition available
CAES	Capabilities Assessment Expert System
CAST	Combined Arms Staff Trainer
CAST	Center for Air/Sea Technology
CD-ROM	Compact Disk - Read Only Memory
CIA	Central Intelligence Agency
CINCPACFLT	Commander in Chief, Pacific Fleet
CME	Counter Measures Evaluator
CMS	Common Mapping Standard
CNMOC	Commander Naval Meteorology and Oceanography Command
COEA	Close Operational Environmental Area
COMINEWARCOM	Commander, Mine Warfare Command
COMNAVSPECWARCOM	Commander, Naval Special Warfare Command
COMSUB	No definition available
COMTRACOMPACFLT	Commander, Training Command, Pacific Fleet
CONUS	Continental United States
COSMIC	No definition available
COSO	No definition available
CRG	Compressed Raster Graphics
CSS	Coastal Systems Station
CV-ASWM	Aircraft carrier, antisubmarine warfare module
CVWST	Carrier Weapon Systems Trainer
CZCS	Coastal Zone Color Scanner
DAFIF	Digital Aeronautical Flight Information File
DARPA	Defense Advanced Research Projects Agency
DBDB	Digital Bathymetric Database
DBMS	Database Management System
DCW	Digital Chart of the World
DEM	Digital Elevation Model
DFAD	Digital Feature Analysis Data
DIA	Defense Intelligence Agency
DIGEST	Digital Geographic Information Exchange Standard
DIS	Distributed Interactive Simulation
DLG	Digital Line Graph
DMA	Defense Mapping Agency
DMAP	Digital Mapping, Charting, and Geodesy Analysis Program
dMC&G	digital Mapping, Charting, and Geodesy
DMSO	Defense Modeling and Simulation Office
DMSP	Defense Meteorological Satellite Program
DNC	Digital Nautical Chart
DoD	Department of Defense

Table 1 — Continued

DPPDB	Digital Point Positioning Database
DSAT	Database for SCI Analysis Tools
DSI	Defense Simulation Internet
DTAM	Digital Terrain Mapping System
DTED	Digital Terrain Elevation Data
DTIC	Defense Technical Information Center
ECMOP	No definition available
ECWF	No definition available
ELINT	Electronic Intelligence
EMI	No definition available
ENEWS	Effectiveness of Naval Electronic Warfare Systems
ENWS	No definition available
EO	No definition available
EPL	No definition available
EROS	Earth Resources Orbiting Satellite
ERS	No definition available
ERSI	No definition available
ETOPO5	Earth Topography 5-Minute
EWIR	No definition available
EWOP	No definition available
FAC	No definition available
FACC	Feature and Attribute Coding Catalog
FASTC	No definition available
FLEASWTRACENPAC	Fleet ASW Training Center, Pacific
FLIP	Flight Information Publication
FMCMM	Flexible Monte Carlo Missile Module
FNMOC	Fleet Numerical Meteorology and Oceanography Center
FSTC	No definition available
GDEM	Generalized Digital Environmental Model
GDOP	Geometric Dispersion of Positioning
GEM	No definition available
GEM-SIGRID	No definition available
GEMINI	No definition available
GEMPLX	No definition available
GENTAC	No definition available
GEOMAP	No definition available
GEOSAT	Geodesy Satellite
GFMPPL	Geophysical Fleet Mission Planning Library
GFO	No definition available
GPALS	No definition available
GPS	Global Positioning System
GUAL	No definition available
HARM	High-speed Anti-Radiation Missile
HEPC DB	No definition available
HEPL	No definition available
HiFINS	High Fidelity Communication Network Simulator
HRB	No definition available
HSOC	No definition available
HWS	Historical Wind Speed
HYDY	High Dynamic Vehicle Simulation
IEER	Improved Extended Echo Ranging System
ICAPS	Integrated Carrier ASW Prediction System
IDB	No definition available
IHO	International Hydrographic Organization
IMEMS	No definition available
INO	Institute of Naval Oceanography
ISS	Integrated Ship System
ITD	Interim Terrain Data
JAWS	Joint Armed Forces Staff College Wargaming System
JCEWS	No definition available
JDAS	No definition available
JUPES	No definition available
JOTS	Joint Operational Tactical System
JSOW	Joint Standoff Weapon
LFA	Low frequency array
LOS	Line of sight
M&S	Modeling and Simulation
MADDB	Magnetic Anomaly Detection Database
MAGTF	Marine Air-Ground Task Force

Table 1 — Continued

MARCORSYSCOM	Marine Corps System Command
MATRIX	No definition available
MC&G	Mapping, Charting, and Geodesy
MCG&I	Mapping, Charting, Geodesy and Imagery
MCM	Mine Counter Measures
MDL	Mission Data Loader
MIID	No definition available
MIUW	Mine Underwater Warfare
MIWTIMS	Mine Warfare Tactical Information Management System
MOODS	Master Oceanographic Observation Data Set
MOSS	Mobile Oceanographic Support System
MPS	MH-53E Mission Planning Station
MSDBB	Master Seafloor Digital Database
MSI	Multispectral Imagery
MSIC	No definition available
MSS	Multispectral Scanner
MULTIGEN	No definition available
MSU	Mississippi State University
MTEDS	Mine Countermeasure Tactical Environmental Data Systems
MTWS	Marine Air-Ground Task Force Tactical Warfare Simulation
MUSE	MC&G Utility Software Environment
NASA	National Aeronautics and Space Administration
NATOPS	No definition available
NAVAIR	Naval Air Systems Command
NAVFAC	Naval Facilities Engineering Command
NAVOCEANO	Naval Oceanographic Office
NAVSEA	Naval Sea Systems Command
NAVSPECWARCOM	Naval Special Warfare Command
NAWC	Naval Air Warfare College
NCCOSC	Naval Command, Control and Ocean Surveillance Center
NCEL	Naval Civil Engineering Laboratory
NERF	No definition available
NGDC	National Geophysical Data Center
NID	No definition available
NOAA	National Oceanic and Atmospheric Administration
NODDS	Navy/NOAA Oceanographic Data Distribution System
NOGAPS	Naval Operational Global Atmospheric Prediction System
NORAPS	No definition available
NPS	Naval Postgraduate School
NRaD	Naval Research and Development
NRL	Naval Research Laboratory
NSA	National Security Agency
NSC	National Security Council
NTDS	Naval Tactical Data System
NTSC	Naval Training Systems Center
NUWC	Naval Underwater Weapons Center
NVG	Night Vision Goggles
NWS	National Weather Service
NWTDB	No definition available
OAML	Oceanographic and Atmospheric Master Library
OMI/MMI	Operator Machine Interface/Man Machine Interface
ONR	Office of Naval Research
ONT	Office of Naval Technology
OPORDER	Operational Order
OS	Operating System
P3	Pre-Planned Product Development
PACCMS	No definition available
PEO	Program Executive Office
PICS	No definition available
PIDs	Program Implementation Documents
PINS	Precise Inertial Navigation System
PLRS	Position Location and Reporting System
PPDB	Point Positioning Database
PRI	Pulse Repetition Interval
PTC	No definition available
PTG	No definition available
PVOD	Probabilistic Vertical Obstruction Data
R&D	Research and Development
RMS	Root Mean Square

Table 1 — Continued

RF	Radar Frequency
SAM	Surface to Air Missile
SAR	Search and Rescue
SDI	Strategic Defense Initiative
SDIO SSGM	Strategic Defense Initiative Organization Strategic Scene Generation Model
SDVT	SEAL Delivery Vehicle Trainer
SEAL	Sea-Air-Land
SEABEE	Construction Batallion
SEA-D	No definition available
SEAWifs	Sea Wide Field-of-View Sensor
SERCES	No definition available
SFMPL	Submarine Fleet Mission Program Library
SIMNET	Simulation Network
SLAATS	System Level Air-to-Air Tactical Simulation
SLAM	Standoff Land Attack Missile
SMI	No definition available
SPO	No definition available
SOPFARS	Special Operations Force Planning and Rehearsal System
SPAWAR	Space and Naval Warfare Systems Command
SPOT	Système Probatoire d'Observation de la Terre
SSGM	Strategic Scene Generation Model
SST	Sea Surface Temperature
SSTORM	Scenario-Structured Torpedo Operational Requirements Model
STOW	No definition available
SYSCOM	System Command
TACDEW EGCS	Tactical Advance Direction & EW Env. Generation and Control System
TACMAN	No definition available
TACTRAGRULANT	Tactical Training Group, Atlantic
TACTS	Tactical Aircrew Combat Training System
TAMPS	Tactical Aircraft Mission Planning System
TDA	Tactical Decision Aid
TDUF	Tactical Database Update Facility
TEC	Topographic Engineering Center
TERCOM	Terrain Contour Mapping
TERPES	Tactical Electronic Reconnaissance Processing and Evaluation System
TESS	Tactical Environmental Support System
TIDES	Threat Intelligences Data Extraction Tool
TIGER	Topologically Integrated Geographic Encoding & Referencing
TLAM	Tomahawk Land Attack Missile
TM	Thematic Mapper
TMA	Target Motion Analysis
TMAI	Target Motion Analysis Improvements
TMPC	Theater Mission Planning Center
TMSS	Total Mine Simulation System
TOPEX	No definition available
TOWAN	Tactical Oceanography Wide-Area Network
TPFDD	No definition available
TRE	Threat Receive Equipment
TSI DB	No definition available
TTD	Tactical Terrain Data
TTES	Team Target Enlargement Simulation
TWSEAS	Tactical Warfare Simulation, Evaluation and Analysis System
USMC	U.S. Marine Corps
USGS	U.S. Geological Survey
USMTF	No definition available
UTM	Universal Transverse Mercator
UVMap	Urban Vector Smart Map
VMap	Vector Smart Map
VMR	No definition available
VPF	Vector Product Format
WAC	World Area Codes
WASPS	War-at-Sea Planning System
WDBII	World Data Bank II
WEPTAC	Weapons and Tactics Analysis Center
WGS	World Geodetic System
WMED	World Mean Elevation Data
WMO	World Meteorological Organization
WRAP	Wide-Area Rapid Acoustic Prediction
WVS	World Vector Shoreline

Navy includes the Marine Corps, but the Marine Corps is mentioned where appropriate for emphasis on specific Marine Corps requirements.

Terrain requirements include hydrographic and other Navy-specific requirements.

Feature classes are the logical groupings or overall groupings of features.

Value-added data is dMC&G or related data not typically provided by DMA. It is possible that some value-added data will be provided by DMA in the future.

Features are the geographically significant items (e.g., roads, bridges, piers, etc.).

Attributes describe the feature (e.g., length, width, and height).

Features and attributes are each assigned a feature or attribute code in accordance with the DIGEST FACC standard.

Feature and attribute requirements that are described as “not met” are defined as “features or attributes that have not been met by emerging DMA vector products,” specifically DNC, VMap, ITD, or UVMap, but are required by an M&S program.

Presently, attribute requirements can be linked only to a feature class and not to a particular feature. This is due to a limitation of the questionnaire.

1.3 Methodology

NRL conducted in-person surveys to obtain current and future dMC&G needs of the Navy and Marine Corps M&S community. To obtain consistent responses, DMA provided NRL and the other services with a survey questionnaire. NRL modified this questionnaire to facilitate its use and distributed it to naval commands. One hundred ten questionnaires were included in NRL’s analysis. The information provided by these questionnaires was entered into a database program for analysis, query, and summary. (Note: the questionnaire was primarily oriented toward vector data. Therefore, this report focuses heavily upon vector-based data requirements.) The respondents are listed in Table 2 along with their project title and short project description. The identification number becomes important in Sec. 2.0.

The respondents were chosen by NRL based on earlier results from (1) DMAP requirements analyses; (2) a letter requesting points of contact sent to multiple commands, including SIMNET users, (3) DTIC project participants; and (4) training commands.

All program responses were equally weighted and included. Some repeats exist, but they are statistically insignificant to the numbers mentioned in the report.

All questionnaires collected were provided to DMA for joint DoD analysis with information collected by the Air Force, the Army, and the NSA.

This report groups vector data requirements into 10 feature classes: elevation, hydrography, boundary, physiography, transportation, populated places, vegetation, soil, utility, and industry.

Table 2 — List of Respondents

ID #	Project Title	Description of Project	Point of Contact
001	ONT/NRaD Map Generator Project	The project goal is to provide high speed map/chart displays on Navy surface platforms.	Mr. Frank Martin NRaD Code 414
002	ACDS (Advanced Combat Direction System)	Provide upgrade capability to add maps to existing displays.	Mr. Gerry Chandler NCCOSC
003	Computerized Mapping Caricature	Provide map displays with data overlay capability.	Mr. Larry McCleary NCCOSC 421
004	Undersea Surveillance Projects	Require high-quality charts of coastline, bottom contours, and slope to support system development and evaluate performance of new systems.	Mr. Al Fisher NCCOSC 742
005	MCM Simulation	Primary — test and evaluate tactical decision aids developed in the tactical oceanography program. Secondary — training mechanism for MCM tactical development.	Mr. Rob Goggins NRL Code 7037
006	Tides Program	Develop techniques to improve the tidal collection efficiency of hydrographic survey operations. Improve the tidal prediction module in TESS.	Mr. Larry Hsu NRL Code 7442
007	ENEWS	Digital simulation of electronic warfare receivers.	Mr. Stan Leroy NRL Code 5707
008	Device 2F158, SH2G Weapon System Trainer	Real-time acoustic and flight system trainer.	Mr. Mark McAuliffe NTSC 254
009	CAST (Combined Arms Staff Trainer)	Marine Corps trainer for supporting arms coordination. Artillery, air, mortar-fire coordination.	Mr. John Cobb NTSC 233
010	CVWST, AH1W, SH60B/F, AV-8B, F/A-18	Utilize DTED/DFAD maps and ADRG to support operational flight, tactical, weapon systems, and navigation trainers.	Mr. Steve Hollis NTSC 251
011	TTES (Team Target Enlargement Simulation)	F/A-18 mission rehearsal (ground version). Model air-to-air missiles (mission rehearsal).	Mr. David Fowlkes NTSC 261
012	PC Navigator	Simulate radar return onboard ship for training purposes. Schoolhouse onboard ship.	Mr. John Allen NTSC 253
013	SDVT (SEAL Delivery Vehicle Trainer)	Training and mission rehearsal.	Mr. Bill Morrissey NTSC PDS 14
014	Coastal Mesoscale Modeling	Operational numerical forecasts for Navy, modeling support for field activities.	Dr. Rich Hodur NRL Monterey
015	TOWAN	Simulation for anticruise missiles. Modeling of environment for atmospheric effects on cruise missiles.	Mr. Scott Chubb NRL Code 7230
016	Global Atmospheric Numerical Modeling	Global numerical weather prediction in support of Navy operations and environmentally sensitive applications using NOGAPS.	Dr. Thomas Rosmond NRL Monterey
017	Geology and Geophysics Programs	An application to seafloor mapping.	Mr. Joseph Kravitz ONR 1125GG
018	Meso Physical Oceanography	To understand large-scale physical oceanography (e.g., study eddies, improve capabilities in ASW)	Mr. Dave Evans ONR

Table 2 — Continued

ID #	Project Title	Description of Project	Point of Contact
019	AEAS	To study the propagation of sound in the oceans and define the transfer function of propagation of acoustic signals.	Mr. Ken Dial ONR
020	Coastal Sciences Program	To understand the flow of mechanics and continental shelves, the fluid and sediment mechanics of the near shore.	Mr. Thomas Kinder ONR 1122PO
021	ONR Remote Sensing Program	Remotely sense ocean surface properties using active and passive microwave and optical sensors; understand electromagnetic interaction with ocean surface relating to Navy radar target detection probabilities.	Mr. D. Trizna ONR
022	TMPc	Produce imagery-derived navigation products, plan and analyze TLAM missions, and distribute mission and C2 data. TMPCs operate in both ashore and afloat facilities.	Ms. Gabriella Russell PEO(CU) PMA-281
023	Mesoscale Modeling, Tropical Cyclone Modeling	Weather prediction, ocean predictions, environmental simulation, analysis, data assimilation.	Dr. Simon Chang NRL Code 7220
024	Machine Learning/Sensor-Based Systems	Navy problem domains underwater and onboard ship are simulated. Recent work has also included the air combat domain. The intent is to understand how automated learning can improve robotic control.	Dr. Alan Meyrowitz NRL Code 5510
025	HiFiNS	Modeling and performance analysis for the SDI national missile defense and GPALS communication system.	Mr. Ed Althouse NRL Code 5520
026	WRAP	Modeling of acoustics in ocean. Ocean environment in three dimensions with scattering, bathymetry, active and passive detection, and transmission loss, ambient noise, and water column properties.	Ms. Laurie Fialkowski NRL Code 5160
027	Seafloor Characterization	To simulate bottom effects on emerging ASW systems.	Mr. Michael Czarnecki NRL Code 7420
028	TOWAN	Processing of OAML data (oceanographic data) for use by Fleet.	Mr. Ron Hoppel NRL Code 7351
029	MPS (MH-53E)	Will be used to calculate aircraft weight and balance parameters, performance parameters, route of flight planning, develop the mine countermeasures tactical plan and individual sorties, conduct postmission analysis on completed sortie, evaluate tactical plan, and draft mine countermeasures reports.	CDR Vaughn NAVFAIR PMA 2613
030	TDUF/6.2 and 6.3 Technical Product Development	Hosting and integration of historical databases, synthetic data, exercise data, and synoptic data to describe the physical and tactical environment in which ADMs targeted for combat systems can mature.	Mr. Mike Inaze NUWC Newport
031	SFMPL	Contact management – manage offboard and on-hull sensor data to create the tactical picture. Localization/TMA: compute solutions for organic contacts. Weapons: compute presets and projected placement of launched weapons (torpedoes, cruise missiles and mines).	Mr. John Corbett NUWC Newport
032	Weapons Analysis Facility	Software development to enhance and analyze torpedo performance.	Mr. Ernest Correia NUWC Newport
033	Weapons System Analysis	To find optimum design parameters for ASW subsystems and systems; to support submarine tactical development.	Mr. Mike Petczarski NUWC Newport

Table 2—Continued

ID #	Project Title	Description of Project	Point of Contact
034	SSTORM	Analysis of the effectiveness of myriad underwater weapons systems.	Mr. James Clancy NUWC Newport
035	Multisource Data Fusion	Fusion of organic and nonorganic data.	Mr. Paul Gagnon NUWC Newport
036	TMAI	Antisubmarine warfare.	Mr. Leo Roy NUWC
037	Active Classification Development Program	Develop an automated classification system for underwater objects.	Mr. Jim Syck NUWC New London
038	CAAM	Environmental systems platform, battle group, campaign, multiwarfare analysis.	Mr. Charlie Batts NUWC New London
039	AWTR	To train and test tactical decision-making processes for amphibious commanders, their staffs, and students of amphibious warfare.	LCDR M.I. Rutkowski Navy Amphibious School Little Creek
040	TWSEAS	Use TWSEAS to train MAGTF (Marine Air-Ground Task Force) staffs and evaluate and test their courses of action and concept of operations of the landing plan.	CAPT Chultz, USMC Navy Amphibious School Little Creek
041	Enhanced Naval Wargaming System	Computer wargaming and analysis for naval and joint training.	M.W. Parsons TACTRAGRULANT Virginia Beach
042	OAML Database	Evaluation and prediction of impact of earth physical environment on all aspects of naval/military operations (atmospheric, oceanographic, cartographic, geodeic).	LCDR Virginia Czuba NAVMETOCOM
043	Tactical Oceanography Simulation Library	Generate multidimensional environmental tactical decision aids for Fleet ASW sensors, as well as providing testbeds for evaluating and developing sensors.	Mr. John Ellis NRL Code 7184
044	Meteorology/Ocean Modeling	Operational support of METOC projects: ocean circulation models; meteorological dynamic models, ocean waves, sea ice, meteorological analysis, ocean analyses.	Mr. Leo Clark FNMOC
045	Sea Ice Forecasting	Provide numerical models used by the Navy for sea ice forecasting.	Dr. Ruth Preller NRL Code 7322
046	ICAPS, GFMPL, TESS, OAML, MOSS	Software and hardware deployed aboard naval combat ships. Nature of software is oceanographic/acoustic, meteorological, and electrical applications.	Mr. Roger Bewig NAVOCEANO
047	GDEM	Used to produce various atlas products for the Navy and for the submarine community.	Mr. Ken Countryman NAVOCEANO
048	OAML Ship Noise Database; OAML Wind and Residual Noise Databases	Build databases.	Mr. David Bates NAVOCEANO
049	Software Application Program for TESS3	Atmospheric application program for tactical operation, meteorological analysis, and photo aids.	Mr. Ken Dropco NAVOCEANO

Table 2 — Continued

ID #	Project Title	Description of Project	Point of Contact
050	TOWAN, MOODS Database Transition, Navy Ocean Model and Prediction Projects	To interface modeling and applications in database environments.	Mr. Jim Corbin MSU-CAST (Center for Air/Sea Technology)
051	Integrated Database Management Systems Program	Support applications from all offices across NAVOCEANO area.	Mr. Jeff Moseley NAVOCEANO
052	Multiple Facilities Management and Construction Projects	Geographic Information System for environmental, automated mapping, utilities, and facilities management and engineering support.	Ms. Karol Scott NCEL
053	Crisis Response	SEABEE operations forward base deployment.	Ms. Karol Scott NCEL
054	HYDY	Fighter pilots work with enhanced ACM; air combat training and testing.	Mr. Brian Krinsley NAWC Pt Mugu P2233
055	Anti-Air Weapons Missile Systems	Chart electromagnetic changes.	Mr. Don Zeleny NAWC Pt Mugu
056	TAMPS	Missing planning system for many aircraft.	Mr. Jim Mueksch NAWC Pt Mugu P2366
057	TERPES	Tactical intelligence system for Marine Corps ELINT purposes.	Mr. Jim Mueksch NAWC Pt Mugu P03825
058	Cruise Missiles, UAVs and related mission-planning systems	Concept exploration, design analysis, mission analysis, flight test support, in-service engineering.	Mr. Jim Massey NAWC Pt Mugu P2366
059	Tactical EA-6B Mission Support System WEPTAC	Mission planning for EA-6B aircraft.	LT Keith Miglio NAWC Pt Mugu P2362
060	TIDES	Tactics development (battle group level); weapon system requirements.	Mr. Cliff Stone NAWC China Lake C02432
061	Analysts Work Bench	Scenario development for the HARM cruise missile, ELINT for HARM, and specialty analysis.	Mr. Chuck Hoffman NAWC China Lake C2813
062	Electronic Combat Range	Warfare analysis tool operations research; weapons analysis for future weapons systems.	Mr. Curt Danhauser NAWC China Lake C024304
063	Various Anti-Air Systems	Electronic warfare range; analysis of devices with real-time data.	Mr. Ellis Kappelman NAWC China Lake C3301
064		Engineering analysis and support of weapon acquisitions program of missile systems.	Mr. Larry Peterson NAWC China Lake C291

Table 2 — Continued

ID #	Project Title	Description of Project	Point of Contact
065	SLAATS	Compare weapon systems. Usually air-to-air or air-launched on few-on-few mode (even 1-on-1). In-flight targeting application (on-the-fly model of image [predictive scene, mode, vignette], sensors, target).	Mr. George Palfalvy NAWC China Lake C2903
066	Rapid Targeting	Development of hardware and software to support training ranges (Air Force/Navy).	Mr. Wayne Tanaka NAWC China Lake C215A
067	TACTS	ATR and in-flight mission planning for advanced cruise missiles.	Mr. Mike King NAWC China Lake C39303
068	AMC	We need to know how the weapon performs in operational use. Key aspects are its survivability and lethality. We also need to know the survivability of the JSOW's launch. Analysis applied to air-launched weapons engineering and development specifications.	Mr. Frank Armogida NAWC China Lake C2811
069	JSOW	Evaluate potential flight performance of a mission. Predict impact of potential changes to flight software.	Ms. Nancy Nelson NAWC China Lake C252
070	GPS Analysis	Digital terrain modeling with animated missile flight simulation. The graphics display simulates cockpit display provided by remote infrared seeker.	Mr. Mark Wonnacott NAWC China Lake
071	SLAM Flight Simulation	Train personnel for special operations.	Ms. Nancy Nelson NAWC China Lake C252
072	SLAM with Man-in-Loop	Surveillance with radar acoustic/nonacoustic, video ... display map with radar tracks.	LT Tony Negron COMNAVSPECWARCOM .
073	SOPFARS	Update current DMA products or create special scale topographic products utilizing a DTAM.	Mr. Robert Graf NCCOSC
074	MIUW	Line-of-sight visual simulation (interoperation with the JANUS and EAGLE Army model test battles).	CWO-2 J.J. Schwartz 2D Topographic Platoon
075	General Marine Corps MC&G Support	Command, control, communications, and computers intelligence ('C ⁴ I').	Dr. Michael Zyda NPS CS/ZK
076	NPS Net Project	Training individuals and ship and battle group teams in ASW systems operation and maintenance and tactics.	Mr. Wally Fukamae NCCOSC
077	PACCMS, NPTS, Target Management System	Protection of ships and dock area.	CDR Pete Bishop FLEASWTRACENPAC N66
078	Fleet ASW Training Center, Pacific	Tactical training using scenarios broadcast to multiple units' input using scenario generators, communication networks and imbedded trainers aboard each ship.	Mr. Larry Phillips NCCOSC
079	Waterside Security System	Simulation of propagation effects over terrain. Tactical decision aids for electromagnetic systems.	CDR Mike Anhalt COMTRACOMPACFLT
080	BFTT, Training Aboard Ships	Ms. Amelia Barrios NCCOSC	
081	Tactical Oceanography Electromagnetic Propagation		

Table 2 — Continued

ID #	Project Title	Description of Project	Point of Contact
082	TACDEW EGCS	Muliship Combat Information Center team training.	LCDR Pat Odon FLIASWTRACENPAC
083	CME (Counter Measures Evaluator)	Provides real-time, hardware-in-the-loop, operator-in-the-loop underwater acoustic simulation for mine, torpedo, and sonar weapons and countermeasure development and tactical use.	Mr. Robert Biano CSS
084	JAWS	Test each student seminar developed OPORDER and its TPFDD to determine if appropriate planning was conducted in the area of deployment and sustainment, and verify staff action procedures during employment.	Mr. Dave Feigel Armed Forces Staff College
085	JAWS, JUPES, JDAS (JCEWS Decision Aid System)	Educational. Educate joint officers in how to deploy, employ, and sustain joint and allied forces.	Mr. Bob Klass Armed Forces Staff College
086	CV:ASWM Model 4.3.1	CV:ASWM is a semiautomated command and control system that provides the officer in tactical command with timely, evaluated, and coordinated ASW information for tactical situation monitoring.	Mr. Jim Zoog NAWC Warminster
087	TACTS Range GDOP Analysis	Analyzes GDOP values over TACTS ranges to determine tracking accuracy of range.	Mr. Adam Prince NAWC Warminster
088	Generic Marine Corps dMCC&G Requirements	None provided.	Mr. Kurt Savoie MARCORSYSCOM
089	IEER	IEER is being developed for shallow-water ASW. Currently, the S-3B is the lead platform for system integration.	Mr. Steven McComas NAWC Warminster
090	Advanced Information Technology	TDA; simulation for TDAs; oceanographic and atmospheric modeling; sensor/data fusion, tracking, and correlation.	Ms. Sue Numrich NRL Code 5580
091	ACAAM, WASPS, CASES	Force-level decision support systems.	LT Michelle Duncan CINCPACFLT
092	Life Cycle Facilities Management Information Systems	Our products are used by facilities managers to assist the decision-making process. We address planning, design, construction, operation, and maintenance issues for facilities.	Ms. Karol Scott NCEL
093	Manned Flight Simulation Facility Supporting all DoD Weapon Systems	Each project will have unique requirements and applications that our facility will provide.	Mr. Rick Mills NAWC Pax River SY31
094	NAVOCEANO Model Production	Provide circulation model ancillary products, thermal model products, and wave model products to ocean centers and Fleet users. NAVOCEANO focuses its effort on semiclosed basins.	CDR Bill Smith NAVOCEANO
095	AV-8B	The system provides the mission planner the capability to program the aircraft system with aircraft performance, weapons, communications, routes, and navigational data.	Ms. Janis Lindgren NAWC China Lake C2103
096	Mission Planning Support Systems	Mission planning for aircraft, mission analysis, and rehearsal processing of map data. Production of map databases.	Ms. Janis Lindgren NAWC China Lake C2103
097	AWSIM	Real-time, on-line avionics implementation and utilization of MCG&I database information including MSDDDB, all under NWTDB, to support naval aircraft missions with focus on littoral warfare areas.	Mr. Norman Melleng NAWC Warminster 505

Table 2 — Continued

ID #	Project Title	Description of Project	Point of Contact
098	VH-60N VH-3D .	Cockpit update to improve pilot/gunner workload and situation awareness.	Mr. Bill Darmofal NAWC Warminster
099	AH-1W	Midlife upgrade to the AH-1W.	Mr. Nick Miraless NAWC Warminster 7052
100	Various MCM: C ⁴ I, MIWTIMS MPS, TMSS	Encompasses planning, tasking, execution, evaluation, analysis, and training for all MCM operations and the development and passing of minefield planning information to mine-laying assets.	Ms. Lori Blackburn COMINEWARCOM
101	Minefield Planning Office	Operations/functions support of analysis for minefield planning.	Mr. Bob O'Connell COMINEWARCOM
102	Team Target Engagement	To train members of small infantry units in individual combat skills.	CWO-2 J.J. Schwartz 2D Topographic Platoon, USMC
103	Targeting and Fire Control	Air-to-air strike and air-to-surface targeting and fire control.	Mr. Al Sutton NAWC China Lake C21301
104	SEAL Delivery Vehicle Trainer	BUDS training and requalification.	LCDR Joalan Fuller NAVSPECWARCOM
105	Geothermal Programs	We do not have specific projects, but require remote sensing and other digital data for COSO geothermal resource area operation and exploration of other possible geothermal sites.	MAJ P.D. Connally MARCORSYSCOM C2G
106	MTWS	MAGTF staff training.	Mr. Frank Monastero NAWC China Lake C8306
107	MTEDS	Performance and prediction of MCM sonars, mine neutralization, minesweeping, and the effects of the environment on this performance.	Mr. Roger Meredith NRL Code 7172
108	SDIO SSGM	Physics-based scene generation for SDIO application.	Dr. Harry Heckathorn NRL Code 4104
109	Survivability and Lethality Division	Vulnerability analysis (physical damage), susceptibility analysis (engagement analysis), endgame analysis (fusing/warhead effects), signature prediction, mission effectiveness (COEA support), survivability analysis (COEA support).	Mr. Robert Meyer NAWC China Lake C2186
110	SERCES, BBS/DIS, STOW	Integrating/interfacing simulations and simulators with the Distributed Interactive Simulation network. This normally contains “advanced interface units” (VMR, real-time OS (VxWorks)), daily data loggers, semiautomated or computer-generated forces, plan view displays and 30 viewing systems.	Mr. Doug Hardy NCCOSC RDT&E

1.4 Organization of Report

Section 2.0 begins with Navy requirements that are not satisfied by DMA's emerging medium- and high-resolution vector products: VMap, ITD, UVMap, and DNC. Current and future requirements are analyzed individually against these four emerging DMA vector products. Note that these DMA products contain overlapping feature classes and features that introduce some repetition in the second part of this analysis.

Section 3.0 describes current and future Navy requirements for feature and attribute information in detail. This detail includes such information as feature or attribute identification, accuracy and resolution (relative and absolute for vertical and horizontal), currentness, display requirements, and geographical areas. This section also provides multiple figures and tables to describe the Navy requirements and reviews the requirements from a feature class or coverage perspective.

Section 4.0 presents current and future Navy requirements for DMA products and discusses value-added data. Additionally, deficiencies noted in this analysis on a DMA product are identified in multiple figures and tables.

2.0 FEATURE AND ATTRIBUTE REQUIREMENTS NOT MET BY EMERGING DMA PRODUCTS

This section summarizes survey results that identify the current feature and attribute requirements of the M&S community that are not met by the emerging DMA vector products (DNC, VMap, ITD, and UVMap). These results are shown in Tables 3 and 4 and are divided by feature class. Table 3 represents the current and future deficient feature and attribute requirements identified by the respondents. Table 4, grouped by feature class, lists by identification number the Navy programs that have these unmet current and future feature and attribute requirements. The Navy programs and their identification numbers are listed in Table 2.

This section also compares all identified current and future requirements (all requirements identified from this effort are compared against the noted emerging DMA vector product prototype specification) against the latest DNC, VMap, ITD, and UVMap prototype specifications in Tables 5 through 8. Each product is reviewed individually without regard to feature and attribute capabilities contained in the other three emergent DMA products. This comparison was made because of the existing feature class, feature, and attribute redundancy already contained in the four emerging DMA products. Note that a recommendation of this report is to perform a detailed analysis, as soon as possible, to either alleviate the overlapping feature classes, features, and attributes or to establish guidelines for the user on when to use each product, feature class, feature, or attribute. When the analysis is complete, the redundancies listed in Tables 5 through 8, as well as the already existing redundancies contained in the DNC, VMap, ITD, and UVMap, could be removed.

2.1 DNC

Table 5 presents current and future DNC requirements not being met by feature class. According to the survey, most of the new feature requirements for all feature classes are weapon system or program specific. In the hydrography feature class, for example, the mine warfare community and sonar-type programs require a higher level information and false target coverage than currently provided.

Table 3 — Current and Future Requirements* Not Met by VMap, ITD, DNC, or UVMAP

Feature Class	Feature	Attribute
Elevation	Berm/Barricade, Ridge Line, Shaded Relief	Standard Deviation , Height Accuracy, Lineage, Albedo, Emissivity, Radar Reflectivity, Location, Min/Max/Medial Elevation, RMS Variability, <i>Location Accuracy</i>
Transportation	DFAD Features , Distance Marker, Route Marker, Fueling Areas, <i>Subways</i>	DFAD Attributes , Slope, Orientation to North, Lineage, Albedo, Emissivity, Radar Reflectivity, FLIP/DAFIF Information, Location, <i>IR & NVG</i>
Vegetation	DFAD Features , Bog, Open/Meadow/Pasture, Sea Growth	DFAD Attributes , Orientation to North, Subsurface Material, Shrub, Height Accuracy, Lineage, Summer % Density, Winter % Density, Albedo, Emissivity, Radar Reflectivity, <i>IR & NVG, Radio Frequency</i>
Hydrography	DFAD Features, Sound Speed Profiles, Surf, Spoil/Disposal Area, Maritime Station, Shipping Density/Distribution, Bottom Type (acoustic), False Acoustic Targets, Mine-Like Objects, Underwater Canyons, Seamount, Shallow-Water Features, Ground Surface, Rock Formation, Cave, Sand Dunes or Hills, Standard Worldwide Harbor Data, Underwater Channels, Underwater Pinnacles, Underwater Ridges, Water Information, Shelf	Beach Slope, DFAD Attributes , Lineage, Albedo, Emissivity, Radar Reflectivity, Location, Riverine, Roughness Characteristics, Water Parameters, <i>Bottom Hardness, Depth of Sediment Layer</i>
Populated Place	None	Density of Roof Cover, Entrance/Exit, Window-Specific, Window-General, Interior Floor Plan, Address, Occupant, Height Accuracy, Lineage, Albedo, Emissivity, Radar Reflectivity, Building Traits, <i>IR & NVG, Population, Location, Size of Ext. Walls of Large Buildings</i>
Industry	Blast Furnace	Roof Type, Surface Material, Density of Roof Cover, Entrance/Exit, Window-Specific, Window-General, Interior Floor Plan, Address, Occupant, Albedo, Emissivity, Radar Reflectivity, Location, <i>IR & NVG, Methods (nets, traps, etc.), Cross-Sectional Areas</i>
Soil	Plain Dirt, Rocky Terrain, <i>Beach</i>	Confidence of Interpretation, Lineage, Albedo, Emissivity, Radar Reflectivity, <i>IR & NVG, Acoustic, Magnetic, Pressure, Thermal Mass, Conductance, Radio Frequency</i>
Physiography	Ridge Line	Height Accuracy, Lineage, Albedo, Emissivity, Radar Reflectivity, Location, <i>Acoustic/Magnetic/Pressure Properties, Age, IR & NVG, Thickness</i>
Utility	Water Treatment Plant, Communication Nodes, Condensation Line, Steam Line, Telephone Station	Roof Type, Surface Material, Orientation to North, Density of Roof Cover, Entrance/Exit, Window-Specific, Window-General, Interior Floor Plan, Address, Occupant, Composition of Tower, Number of Cables in Conduit, Height Accuracy, Lineage, Albedo, Emissivity, Radar Reflectivity, <i>IR & NVG, kilovoltamperes, Density of Tree Cover, Probability to Kill, Radar Cross Section</i>
Boundary	Key Tracking Area, Restricted Airspace Boundary, Sensitivity Areas, Low-Intensity Conflict Areas	Surface Material, Orientation to North, Height Accuracy, Albedo, Emissivity, Radar Reflectivity, Location, <i>Acoustic/Magnetic/Pressure Properties, Boundary Conditions (e.g., barbed-wire fence), Controller of Boundary</i>

*Current Requirement Only
 Current and Future Requirement
Future Requirement Only

Table 4 — Current and Future Requirements* Not Met by VMap, ITD, DNC, or UVMap by Program ID Number

ELEVATION	
Feature	Program ID Number
Berm/Barricade Ridge Line Shaded Relief	010, 011, 030, 035, 043, 052, 053, 076, 090, 092, 100, 101, 104, 109 010, 017, 023, 030, 035, 043, 051, 052, 053, 090, 092, 095, 098, 099, 100, 101, 109 062, 067 , 072, 091
Attribute	Program ID Number
Height Accuracy Lineage Albedo Emissivity Radar Reflectivity Location <i>Location Accuracy</i> Min/Max/Medial Elevation RMS Variability Standard Deviation	001, 008, 010, 011, 012, 017, 022, 023 , 027, 029, 030, 035, 043, 044, 046, 050, 052, 053, 054, 056, 057, 058, 059, 061, 062, 063, 064, 066, 068, 069, 070, 071 , 073, 074, 075, 080, 083, 087, 088, 090, 091 , 092, 095, 098, 099, 100, 102, 103, 105, 109 010, 012, 017, 022, 029, 030, 039, 043, 053, 054, 061, 062, 064, 066, 068, 071 , 073, 088, 092, 095, 098, 099, 100, 101, 104 016 066 054 , 066 050 050 044 044 023
TRANSPORTATION	
Feature	Program ID Number
Distance Marker Route Marker DFAD Features Fueling Areas Subways	009, 010, 011 , 013, 035, 052, 053, 061, 062, 064, 066, 068, 074, 075, 088, 090, 092, 097, 098, 099, 100, 102, 104 009, 010, 011 , 013, 035, 052, 053, 062, 064, 066, 068, 075, 088, 090, 092, 095 , 097, 098, 099, 100, 102, 104 068 100 011
Attribute	Program ID Number
Slope Orientation to North Lineage Albedo Emissivity Radar Reflectivity FLIP/DAFIF Information <i>IR & NVG</i> Location	010, 011 , 012, 013, 040, 052, 053, 058, 064, 066, 068, 073, 075, 088, 090, 092, 095, 098, 099, 100, 102, 103, 104, 108, 109, 110 010, 011 , 012, 013, 041, 052, 053, 060, 064, 066, 068, 080, 088, 090, 091, 092, 093, 095, 098, 099, 100, 102, 103, 104, 108, 109, 110 010, 013, 052, 053, 054 , 060, 061, 064, 066, 068, 088, 090, 095 , 100 016 066 066 029 010 101
VEGETATION	
Feature	Program ID Number
Bog Open/Meadow/Pasture Sea Growth DFAD Features	010, 012, 013, 014 , 015 , 016, 040, 044, 049, 051, 052, 053, 061, 064, 066, 068, 074, 075, 076, 088, 090, 091, 092, 093, 102, 104, 106, 108, 109 010, 012, 016, 023, 040, 044, 049, 051, 052, 053, 061, 064, 066, 068, 075, 076, 084, 088, 090, 091, 093, 095, 096, 102, 104, 106, 108, 109 100 068

*Current Requirement Only
Current and Future Requirement
Future Requirement Only

Table 4 — Continued

Attribute	Program ID Number
Orientation to North	010, 013, 023, 049, 052, 053, 060, 066, 068, 074, 088, 090, 092, 095, 098, 099, 100, 101, 103, 104, 108
Subsurface Material	010, 013, 023, 044, 052, 053, 061, 064, 066, 068, 076, 088, 090, 092, 102, 104, 108
Shrub	010, 013, 040, 044, 049, 052, 053, 060, 066, 068, 076, 088, 090, 092, 102, 104, 106, 108, 109
Height Accuracy	010, 013, 023, 040, 044, 052, 053, 058, 060, 061, 062, 064, 066, 068, 075, 088, 090, 092, 095, 098, 099, 100, 101, 102, 103, 104, 108
Lineage	010, 013, 040, 052, 053, 060, 061, 064, 066, 068, 088, 090, 092, 102, 104
Summer % Density	010, 011, 013, 015, 016, 044, 052, 053, 060, 066, 068, 075, 088, 090, 092, 095, 100, 102, 103, 104, 108
Winter % Density	010, 011, 013, 015, 016, 044, 052, 053, 060, 066, 068, 075, 088, 090, 092, 095, 100, 102, 103, 104, 108
Albedo	010, 016
Emissivity	066
Radar Reflectivity	066
DFAD Attributes	068
IR & NVG	010
Radio Frequency	065
HYDROGRAPHY	
Feature	Program ID Number
Spoil/Disposal Area	005, 009, 010, 011, 012, 013, 029, 037, 051, 052, 053, 061, 062, 066, 073, 076, 088, 090, 092, 093, 100, 102, 104
Maritime Station	003, 010, 012, 013, 029, 037, 053, 060, 061, 062, 066, 073, 076, 082, 088, 090, 091, 092, 095, 101, 102, 104, 109, 110
Shipping Density/ Distribution	026
Bottom Type (acoustic)	050
DFAD Features	068
False Acoustic Targets	005
Mine-Like Objects	005
Sound Speed Profiles	026
Surf	015
Standard Worldwide Harbor Data	082
Underwater Channels	008
Underwater Pinnacles	008
Underwater Ridges	008
Water Information	065, 107
Underwater Canyons	005
Seamount	005, 089
Shelf	089
Shallow-Water: Ground Surface, Rock Formation, Cave, Sand Dunes or Hills	107
Attribute	Program ID Number
Lineage	010, 012, 013, 028, 052, 053, 060, 061, 064, 066, 080, 092, 101, 102, 104, 107
Albedo	016
Emissivity	066
Radar Reflectivity	066
Beach Slope	015
DFAD Attributes	068
Bottom Hardness	089

Table 4 — Continued

Attribute	Program ID Number
<i>Depth of Sediment Layer</i>	089
Location	028, 048
Riverine	073
Roughness Characteristics	020
Water Parameters	107
POPULATED PLACE	
Feature	Program ID Number
N/A	N/A
Attribute	Program ID Number
Density of Roof Cover	010, 011, 012, 013, 044, 052, 053, 061, 062, 066, 088, 090, 092, 098, 099, 102, 103, 104
Entrance/Exit	010, 011, 013, 040, 052, 053, 066, 075, 088, 090, 092, 095, 102, 104, 109
Window-Specific	010, 011, 013, 052, 053, 066, 076, 088, 090, 092, 102, 103, 104
Window-General	010, 011, 013, 052, 053, 066, 076, 088, 090, 092, 102, 104, 109, 110
Interior Floor Plan	010, 011, 013, 052, 053, 066, 076, 088, 090, 092, 102, 104, 110
Address	010, 011, 013, 052, 053, 066, 088, 090, 092, 098, 099
Occupant	010, 011, 013, 052, 053, 066, 076, 088, 090, 092, 098, 099
Height Accuracy	010, 011, 012, 013, 052, 053, 054, 058, 061, 062, 064, 066, 076, 088, 090, 092, 095, 098, 099, 102, 103, 104
Lineage	010, 011, 012, 013, 052, 053, 061, 064, 066, 088, 090, 092, 102, 104
Albedo	016
Emissivity	066
Radar Reflectivity	066
Building Traits	102
IR & NVG	010
<i>Size of Ext. Walls of Large Buildings</i>	054
Population	056, 057
Location	089, 093
INDUSTRY	
Feature	Program ID Number
Blast Furnace	010, 011, 012, 013, 052, 053, 058, 061, 064, 066, 076, 088, 090, 092, 093, 102, 103, 104, 109
Attribute	Program ID Number
Roof Type	010, 011, 012, 013, 052, 053, 058, 061, 062, 066, 076, 088, 090, 091, 092, 098, 099, 102, 104
Surface Material	010, 011, 012, 013, 049, 052, 053, 054, 058, 061, 062, 066, 076, 088, 090, 091, 092, 095, 096, 102, 103, 104, 108
Density of Roof Cover	010, 011, 012, 013, 052, 053, 058, 062, 066, 088, 090, 092, 098, 099, 102, 104
Entrance/Exit	010, 011, 013, 052, 053, 066, 088, 090, 092, 095, 100, 102, 104, 109
Window-Specific	010, 011, 013, 052, 053, 066, 076, 088, 090, 092, 102, 103, 104
Window-General	010, 011, 013, 052, 053, 066, 076, 088, 090, 092, 102, 104, 108, 109
Interior Floor Plan	010, 011, 013, 052, 053, 066, 076, 088, 090, 092, 102, 104
Address	010, 011, 013, 052, 053, 066, 076, 088, 090, 092, 101
Occupant	010, 011, 013, 052, 053, 066, 076, 088, 090, 092, 098, 099, 101
Albedo	016
Emissivity	066
Radar Reflectivity	066
Location	093
<i>Cross-Sectional Areas</i>	054

Table 4 — Continued

Attribute	Program ID Number
IR & NVG Methods (nets, traps, etc.)	010 100
SOIL	
Feature	Program ID Number
Beach	050
Plain Dirt	093
Rocky Terrain	093
Attribute	Program ID Number
Confidence of Interpretation	010, 011, 013, 017, 044, 050, 052, 053, 058, 061, 062, 064, 065, 066, 068, 073, 076, 088, 091, 092, 100, 101, 104, 105, 107, 108, 109
Lineage	010, 011, 013, 040, 044, 052, 053, 054, 060, 061, 062, 064, 066, 101, 104, 107
Albedo	016
Emissivity	066
Radar Reflectivity	066
Thermal Mass	068
Conductance	068
IR & NVG	010
Acoustic/Magnetic/Pressure Properties	083
Radio Frequency	065
PHYSIOGRAPHY	
Feature	Program ID Number
Ridge Line	063
Attribute	Program ID Number
Height Accuracy	010, 012, 013, 017, 027, 030, 032, 046, 050, 052, 053, 054, 058, 061, 062, 063, 064, 066, 076, 080, 082, 088, 090, 092, 095, 096, 098, 100, 102, 103, 104, 105, 107, 109
Lineage	010, 013, 023, 028, 030, 044, 052, 053, 054, 061, 062, 066, 080, 082, 088, 090, 092, 095, 104, 105
Albedo	016
Emissivity	066
Radar Reflectivity	066
Location	047, 048, 050
Acoustic/Magnetic/Pressure Properties	083
Age	019
IR & NVG	010
Thickness	019
UTILITY	
Feature	Program ID Number
Water Treatment Plant	009, 010, 011, 012, 013, 040, 049, 052, 053, 054, 058, 061, 062, 066, 068, 073, 076, 088, 090, 091, 092, 093, 101, 102, 103, 104, 106, 108, 109
Communication Nodes	066
Condensation Line	053
Steam Line	053
Telephone Station	054, 057, 061

Table 4 — Continued

Attribute	Program ID Number
Roof Type	010, 011, 012, 013, 052, 053, 058, 061, 062, 066, 068, 088, 090, 091, 092, 098, 099, 102, 104, 106, 108, 109
Surface Material	010, 011, 012, 013, 049, 052, 053, 054, 058, 061, 062, 066, 068, 073, 076, 088, 090, 091, 092, 095, 100, 102, 103, 104, 106, 108, 109
Orientation to North	010, 011, 012, 013, 041, 049, 052, 053, 066, 068, 088, 090, 091, 092, 093, 095, 098, 099, 100, 102, 103, 104, 105, 106, 108, 109
Density of Roof Cover	010, 011, 012, 013, 052, 053, 062, 066, 068, 088, 090, 092, 098, 099, 102, 104
<i>Density of Tree Cover</i>	010, 011, 012, 013, 052, 053, 062, 066, 068, 088, 090, 092, 102, 104, 108
Entrance/Exit	010, 011, 013, 052, 053, 066, 068, 075, 088, 090, 092, 102, 104, 109
Window-Specific	010, 011, 013, 052, 053, 066, 068, 076, 088, 090, 092, 102, 103, 104
Window-General	010, 011, 013, 052, 053, 066, 068, 076, 088, 090, 092, 102, 104, 109
Interior Floor Plan	010, 011, 013, 052, 053, 066, 068, 076, 088, 090, 092, 102, 104
Address	010, 011, 013, 052, 053, 057, 066, 068, 076, 088, 090, 092, 101
Occupant	010, 011, 013, 052, 053, 066, 068, 076, 088, 090, 092, 098, 099, 101
Composition of Tower	010, 011, 012, 013, 049, 052, 053, 058, 061, 062, 066, 068, 076, 084, 088, 090, 092, 096, 099, 102, 103, 104, 108
Number of Cables in Conduit	007, 010, 011, 013, 052, 053, 061, 062, 066, 068, 076, 088, 090, 092, 104, 105
Height Accuracy	010, 011, 012, 013, 022, 052, 053, 054, 058, 061, 062, 066, 076, 088, 090, 091, 092, 095, 098, 099, 100, 102, 103, 104, 105, 108
Lineage	010, 011, 013, 022, 052, 053, 054, 061, 062, 066, 068, 076, 090, 091, 092, 095, 104
Albedo	016
Emissivity	066
Radar Reflectivity	066
IR & NVG	010
Kilovoltamperes	053
<i>Probability to Kill</i>	068
<i>Radar Cross Section</i>	054
BOUNDARY	
Feature	Program ID Number
Key Tracking Area	067
Restricted Airspace Boundary	063
Sensitivity Areas	053
Low-Intensity Conflict Areas	053
Attribute	Program ID Number
Surface Material	010, 012, 013, 017, 020, 032, 046, 052, 053, 058, 061, 066, 076, 088, 090, 092, 100, 102, 104, 108, 109
Orientation to North	001, 002, 010, 013, 017, 030, 041, 043, 044, 046, 052, 053, 060, 066, 074, 080, 088, 090, 091, 092, 095, 096, 098, 099, 100, 102, 103, 104, 105, 108, 109, 110
Height Accuracy	010, 013, 017, 020, 046, 052, 053, 058, 061, 062, 063, 066, 074, 076, 088, 090, 092, 095, 098, 099, 100, 102, 103, 104, 105
Albedo	016
Emissivity	066
Radar Reflectivity	066
Location	007, 045, 047, 048, 050, 089
Acoustic/Magnetic/ Pressure Properties	083
Boundary Conditions (e.g., barbed-wire fence)	052
Controller of Boundary	100

Table 5 — Current and Future Requirements* Not Met by DNC Prototype 3.0

Feature Class	Features	Attributes
Elevation	Slope Polygon, Depression, Berm/Barricade, Ridge Line	Location, Radar Reflectivity, Min/Max/Medial Elevation, <i>Location Accuracy</i>
Transportation	DFAD Features , Trail, Cart Track, Culvert, Ford, RR Siding/Spur, RR Turntable, Tramway/Incline Railway, Distance Marker, Rest/Vehicle Stopping Area, Route Marker, Vehicle Storage/Vehicle Parking, Dragon (Tiger) Teeth, Apron/Hardstand, Overrun/Stopway, Snowshed/Rock Shed	DFAD Attributes , Superstructure Description, Substructure Description (spans), Name, Lineage, Location, Radar Reflectivity
Vegetation	DFAD Features , Cropland, Hedge Row, Grassland, Scrub/Brush, Bamboo/Cane, Firebreak/Cleared Way, Oasis, Bog, Hummock, Open/Meadow/Pasture, Coral Reef, Sea Growth	Terraced, Open, Shrub, Summer % Density, Winter % Density, Height Accuracy, Lineage, Radar Reflectivity
Hydrography	Surf , Spring/Water Hole, Ditch, Penstock, Spoil/Disposal Area, Maritime Station, Shipping Density/Distribution, Bottom Type (acoustic), False Acoustic Targets, Mine-Like Objects, Sound Speed Profiles, Seamount, Underwater Canyon, Shallow-Water Features: Ground Surface, Rock Formation, Cave, Sand Dunes/Hills, <i>Standard Worldwide Harbor Data, Water Information, Underwater Pinnacles, Underwater Ridges, Underwater Channels, Continental Shelf</i>	DFAD Attributes , Lineage, Radar Reflectivity, Location, Roughness Characteristic, Riverine Attributes, <i>Depth of Sediment Layer, Bottom Hardness</i>
Populated Place	Plaza/City Square, Hut, Shanty Town, Tent Dwelling, Underground Dwelling, Trailer Park, Campground/Campsite, Ski Jump	Height Accuracy, Lineage, Radar Reflectivity, Location
Industry	Catalytic Cracker, Conveyor, Nuclear Accelerator, Feedlot/Stockyard/Holding Pen, Storage Bunker/Mound, Filtration/Aeration Bed, Flume, Cistern, Blast Furnace, Well, <i>Rig/Superstructure</i>	Name, Radar Reflectivity, Methods (nets, traps, etc.), Location
Soil	Peat, Evaporites, Plain Dirt, Beach	Lineage, Acoustic/Magnetic/Pressure Properties, <i>Depth of Sediment Layer, Thermal Mass/Conductance</i>
Physiography	Rock Formation, Bluff/Cliff/Escarpment, Salt Pan, Cut Line, Geothermal Feature, Ice Cliff, Pack Ice, Polar Ice, Sabkha, Ridge Line, Lava Flow, <i>Riverine Features</i>	Height (above/below surface), Name, Height Accuracy, Lineage, Radar Reflectivity, Location, Age, Acoustic/Magnetic/Pressure Properties, Layer Description, Thickness, <i>Thermal Mass/Conductance, Coverage</i>
Utility	Water Treatment Plant, Utility Line (underwater), Solar Panel, Telephone Station, Dam	Name, Style of Tower, Height Accuracy, Lineage, Radar Reflectivity
Boundary	Boundary Marker, International Dateline, Cease-Fire Line, Control Point, Demilitarized Zone, Restricted Air Space, Sensitivity Area, Low-Intensity Conflict Area	Height Above Ground, Surface Material, Height Accuracy, Location, Radar Reflectivity, Acoustic/Magnetic/Pressure Properties, Controller of Boundary

***Current Requirement Only**

Current and Future Requirement

Future Requirement Only

Table 6 — Current and Future Requirements* Not Met by VMap Prototype 2 Level 2

Feature Class	Features	Attributes
Elevation	Regular Spaced Grid, Triangular Irregular Network, Irregular Network, Slope Polygon, Berm/Barricade, Ridge Line, Shaded Relief	Height Accuracy, Lineage, Location, Albedo, Emissivity, Radar Reflectivity, Min/Max/Medial Elevation, RMS Variability, Standard Deviation, <i>Location Accuracy</i>
Transportation	DFAD Features , Ramp, Distance Marker, Route Marker, Lighthouse, Fueling Areas, Subways	DFAD Attributes , Bridge Load Class, Underbridge Clearance, Slope, Orientation to North, Substructure Description (spans), Route Number, Lineage, Albedo, Emissivity, Radar Reflectivity, FLIP/DAFIF Information, Location, <i>IR & NVG</i>
Vegetation	DFAD Features , Bog, Open/Meadow/Pasture	DFAD Attributes , Surface Material, Orientation to North, Subsurface Material, Wet, Open, Shrub, Summer % Density, Winter % Density, Spacing, Average Stem Diameter, Height Accuracy, Lineage, Albedo, Emissivity, Radar Reflectivity, <i>IR & NVG</i> , <i>Radio Frequency</i>
Hydrography	DFAD Features , Underwater Cable, Shipping Channel, Inland Channel, Current/Flow Arrow, Tunnel/Bridge, Spoil/Disposal Area, Gridiron, Offshore Loading Facility, Maritime Station, Buoy, Electronic Beacon, Light/Lighthouse, Crib, Breaker, Anchorage Area, Pier, Wharf Area, Ship Repair Area/Dry Dock	DFAD Attributes , Position , Left Bank Delineation, Right Bank Delineation, Left Bank Slope, Right Bank Slope, Subsurface Material, Velocity, Lineage, Albedo, Emissivity, Radar Reflectivity, Location, Riverine
Populated Place	None	Roof Type, Surface Material, Density of Roof Cover, Entrance/Exit, Window-Specific, Window-General, Interior Floor Plan, Address, Occupant, Height Accuracy, Lineage, Albedo, Emissivity, Radar Reflectivity, Building Traits, <i>IR & NVG</i> , Population, Location, <i>Size of Ext. Walls of Large Buildings</i>
Industry	Nuclear Accelerator, Blast Furnace	Roof Type, Surface Material, Orientation to North, Density of Roof Cover, Density of Tree Cover, Entrance/Exit, Windows-Specific, Windows-General, Interior Floor Plan, Address, Occupant, Albedo, Emissivity, Radar Reflectivity, Location, <i>IR & NVG</i> , Methods (nets, traps, etc.), <i>Cross-Sectional Areas</i>
Soil	VMap does not contain a soil feature class.	VMap does not contain a soil feature class.
Physiography	Ridge Line	Height Accuracy, Lineage, Albedo, Emissivity, Radar Reflectivity, Location, Acoustic, Magnetic, Pressure, Age, <i>IR & NVG</i> , Thickness
Utility	Water Treatment Plant, Communication Nodes, Condensation Line, Railway, Steam Line, Telephone Station	Roof Type, Surface Material, Orientation to North, Density of Roof Cover, Density of Tree Cover, Entrance/Exit, Window-Specific, Window-General, Interior Floor Plan, Address, Occupant, Composition of Tower, Number of Cables in Conduit, Height Accuracy, Lineage, Albedo, Emissivity, Radar Reflectivity, <i>IR & NVG</i> , Kilovoltamperes, <i>Probability to Kill</i> , <i>Radar Cross Section</i>
Boundary	Key Tracking Area, Restricted Airspace Boundary, Sensitivity Area, Software Boundary, Low-Intensity Conflict Areas	Length, Width, Surface Material, Orientation to North, Height Accuracy, Albedo, Emissivity, Radar Reflectivity, Location, Acoustic/Magnetic/Pressure Properties, Boundary Conditions (e.g., barbed-wire fence), Controller of Boundary

*Current Requirement Only
 Current and Future Requirement
Future Requirement Only

Table 7 — Current and Future Requirements* Not Met by ITD

Feature Class	Features	Attributes
Elevation	Color Overlay , Depth Contour, Land Contour, Regular Spaced Grid, Triangular Irregular Network, Irregular Network, Spot Elevation, Depression, Berm/Barricade, Ridge Line, Shaded Relief	Standard Deviation , Height Accuracy, Lineage, Emissivity, Min/Max/Medial, RMS Variability, Shadowing, Location, Albedo, Radar Reflectivity, Location Accuracy
Transportation	DFAD Features , Trail, Interchange, Culvert, RR Turntable, Tramway, Aerial Cableway, Control Tower, Distance Marker, Rest Area, Route Marker, Vehicle Storage, Aircraft Facility, Aircraft Facility Beacon, Apron/Hardstand, Overrun, Mooring Mast, Anchorage, Dry Dock, Pier/Wharf, Lighthouse, Snowshed/Rock Shed, Fueling Areas	No. of Lanes, No. of Tracks, Bridge Opening, Slope, Orientation to North, Name, Route Number, Lineage, Miles Covered, Radar Reflectivity, Albedo, Emissivity, FLIP/DAFIF, DFAD Attributes, Location
Vegetation	Nursery, Firebreak/Cleared Way, Oasis, Tundra, Bog, Hummock, DFAD Features, Desert Information	Winter % Density , Orientation to North, Name, Subsurface Material, Terraced, Height Accuracy, Lineage, Emissivity, IR & NVG, Albedo, Radar Reflectivity
Hydrography	DFAD Features	DFAD Attributes
Populated Place	Building, Fort, Plaza/City Square, Park, Religious Shrine/Mosque, Hut, Shanty Town, Tent Dwelling, Underground Dwelling, Trailer Park, Cemetery, Athletic Field, Campground, Drive-in Theater, Fairgrounds, Amusement Park, Outdoor Theater/Amphitheater, Golf Course, Race Track, Ski Jump, Stadium, Swimming Pool, Zoo, Monument, Ruins, Building Traits, <i>Subways</i>	Orientation to North, Density of Roof Cover, Entrance/Exit, Window-Specific, Window-General, Interior Floor Plan, Name, Address, Occupant, Type of Building Activity, Height Accuracy, Lineage, City Name, Population, Emissivity, IR & NVG, Albedo, Radar Reflectivity, Location, Building Traits, <i>Size of Ext. Walls on Large Buildings, Cross-Sectional Area</i>
Industry	Processing/Treatment Plant, Chimney/Smokestack, Cooling Tower, Tower (noncommunication), Disposal Site/Waste Pile, Wrecking/Scrap Yard, Catalytic Cracker, Settling Basin, Conveyor, Crane, Flare Pipe, Tank, Water Tower, Nuclear Accelerator, Windmill, Feedlot/Stockyard, Grain Bin, Grain Elevator, Silo, Storage Bunker, Mine, Quarry, Filtration/Aeration Bed, Fish Hatchery, Flume, Salt Evaporator, Cistern, Blast Furnace, Fish Industry, Well	Albedo , Roof Type, Orientation to North, Density of Roof Cover, Entrance/Exit, Window-Specific, Window-General, Interior Floorplan, Name, Address, Occupant, Type of Processing Industry, Methods (nets, traps, etc.), Emissivity, IR & NVG, Radar Reflectivity, Location
Soil	Rocky Terrain, Plain Dirt, Beach, Pinnacles, Ridge Line, Rocky Terrain	Confidence of Interpretation, Lineage, Acoustic/Magnetic/Pressure Properties, IR & NVG, Albedo, Radar Reflectivity, Emissivity, IR, SAR, Electro-Optical Reflectivity, Thermal Mass Conductance
Physiography	Mountain Pass, Rock Formation, Bluff/Cliff, Crevice/Crevasse, Cave, Glacial Moraine, Asphalt Lake, Salt Pan, Cut Line, Esker, Fault, Geothermal Feature, Sand Dunes/Hills, Glacier, Ice Cliff, Ice Peak/Nunatak, Ice Shelf, Pack Ice, Polar Ice, Snow/Ice Field, Sabka, Volcano, Void Collection Area, Ridge Line, Beach Slope, Lava Flow, Pinnacles, Shelf	Orientation to North, Name, Height Accuracy, Lineage, Emissivity, IR & NVG, Albedo, Radar Reflectivity, Location, Acoustic/Magnetic/Pressure Properties, Thickness, Age

*Current Requirement Only
 Current and Future Requirement
Future Requirement Only

Table 7 — Continued

Feature Class	Features	Attributes
Utility	Power Plant, Water Treatment Plant, Transformer Substation, Pumping Station, Power Transmission Line, Telephone Line, Utility Line, Tower (communication), Underground Pipeline, Solar Panel, Communication Nodes, Condensation Line, Steam Line, Telephone Station	Albedo, Roof Type, Orientation to North, Density of Roof Cover, Density of Tree Cover, Entrance/Exit, Window-Specific, Window-General, Interior Floor Plan, Name, Address, Occupant, Type of Utility/Line, Composition of Tower, Style of Tower, No. of Cables in Conduit, Height Accuracy, Lineage, Kilovoltamperes, Emissivity, IR & NVG, Radar Reflectivity, Location, <i>Probability to Kill, Radar Cross Section</i>
Boundary	Administrative Boundary, De Facto Boundary, Coastal Shoreline, International Dateline, Armistice Line, Cease-Fire Line, Fence, Cairn, Restricted Airspace, Low-Intensity Conflict Areas, Sensitivity Areas, Demilitarized Zones, Key Tracking	Height Accuracy, Orientation to North, Name, Emissivity, Albedo, Radar Reflectivity, Location, Software Boundary, Acoustic/Magnetic/Pressure Properties, Boundary Conditions (i.e., barbed-wire fence), Controller of Boundary, Location

Overall, the feature attribute requirements are much more detailed than the DNC currently provides. New attributes also appear, in particular, “radar reflectivity” and “location, which are requirements in almost every layer.

2.2 VMap Level 2

Table 6 presents current and future VMap requirements not being met by feature class. Among those features and attributes explicitly stated on the questionnaire, VMap provides excellent coverage. Several feature classes (e.g., populated places, industry, physiography) are complete in that almost all required features are included. However, some attributes are missing—namely, a good portion of those that were listed in the “others” category. Specifically, albedo, emissivity, radar reflectivity, and location are commonly requested for each feature class and do not appear as part of VMap.

In a more general context, VMap does not incorporate a soil feature class. Several programs gave specific details necessary to fulfill requirements in this missing layer. Additionally, the hydrography layer has several “not met” features because certain water information is not intended for VMap inclusion.

2.3 ITD

Table 7 presents current and future ITD requirements not being met by feature class. The ITD vector product is designed to describe militarily significant land features. A large number of the survey responses covered land areas, so the ITD requirements were compared to the requirements identified in the survey. To account for the terrestrial nature of ITD, feature classes (hydrography), features (i.e., bathymetry), and attributes that were exclusively concerned with the marine environment were not considered for the ITD comparison. Even so, a large number of features and attribute requirements were found to be missing. Table 7 is conservative in the sense that if there was doubt as to whether a given feature or attribute were included in ITD, they were listed as missing.

Table 8 — Current and Future Requirements* Not Met by UVMap Product Specification 5 Nov 92

Feature Class	Features	Attributes
Elevation	Depth Contour, Slope Polygon, Depression, Berm/Barricade, Ridge Line, Shaded Relief, Benchmark	Standard Deviation, Albedo, Lineage, Location, Min/Max/Medial Elevation, RMS Variability, Radar Reflectivity, Emissivity
Transportation	DFAD Features, Culvert, RR Turntable, Tramway/Incline Railway, Distance Marker, Rest/Vehicle Stopping Area, Vehicle Storage/Vehicle Parking, Dragon (Tiger) Teeth, Anchorage, Snowshed/Rock Shed, Fueling Areas	DFAD Attributes, Miles Covered (span, distance), Substructure Description (spans), Lineage, Radar Reflectivity, Emissivity, IR & NVG, Albedo, FLIP/DAFIF Information for Air Facilities, Location
Vegetation	Coral Reef, Sea Growth, DFAD Features	Emissivity, DFAD Attributes, Radar Reflectivity, IR & NVG, Albedo, Radio Frequency, Electro-Optical Reflectivity
Hydrography	Surf, DFAD Features, Smoke, Waterfall, Sounding, Piling, Rock, Wreck, Underwater Cable, Shipping Channel, Inland Channel, Rapids, Tunnel/Bridge, Spoil/Disposal Area, Gridiron, Offshore Loading Facility, Maritime Station, Buoy, Electronic Beacon, Light/Lighthouse, Crib, Breaker, Anchorage Area, Pier, Reef, Wharf Area, Ship Repair Area/Dry Dock, Bottom Sample, Misc: Underwater Feature, Standard Worldwide Harbor Data, Shallow-Water Features: Ground Surface, Rock Formation, Cave, Sand Dunes/Hills	DFAD Attributes, Left Bank Delineation, Right Bank Delineation, Left Bank Slope, Right Bank Slope, Subsurface Material, Velocity, Lineage, Location, Riverine Attributes, Radar Reflectivity, Emissivity, Albedo
Populated Place	None	Roof Type, Surface Material, Density of Roof Cover, Entrance/Exit, Window-Specific, Window-General, Interior Floor Plan, Address, Occupant, Height Accuracy, Lineage, Population, Location, Building Traits, Radar Reflectivity, Emissivity, IR & NVG, Albedo, <i>Cross-Sectional Areas, Size of Ext. Walls of Large Buildings</i>
Industry	Flare Pipe, Windmill/Wind Motor, Blast Furnace, Well, Rig/Superstructure	Roof Type, Surface Material, Density of Roof Cover, Entrance/Exit, Window-Specific, Window-General, Interior Floor Plan, Name, Address, Occupant, Type of Processing Industry, Location, Radar Reflectivity, Emissivity, IR & NVG, Albedo, Methods Used (nets, traps, etc.), <i>Cross-Sectional Areas</i>
Soil	Gravel, Sand, Silt, Clay, Peat, Evaporites, Rock Outcrops, Plain Dirt, Rocky Terrain, Beach	Roughness, Surface Roughness, Layer Description, Grade, Soil Depth, State of Ground, Trafficability, Material Composition, Confidence of Interpretation, Lineage, Ground Wetness, Acoustic/Magnetic/Pressure Properties, Radar Reflectivity, Emissivity, IR & NVG, Albedo, Thermal Mass/Conductance, Radio Frequency
Physiography	Shallow-Water Features: Ground Surface, Rock Formation, Cave, Sand Dunes/Hills, Mountain Pass, Rock Formation, Crevice/Crevasse, Cave, Glacial Moraine, Esker, Geothermal Feature, Glacier, Ice Cliff, Ice Peak/Nunatak, Ice Shelf, Pack Ice, Polar Ice, Snow/Ice Field, Volcano, Void Collection Area, Lava Flow, Ridge Line	Acoustic/Magnetic/Pressure Properties, Height Accuracy, Lineage, Thickness, Material Composition, Age, Width, Location, Radar Reflectivity, Emissivity, IR & NVG, Albedo

*Current Requirement Only
 Current and Future Requirement
 Future Requirement Only

Table 8 — Continued

Feature Class	Features	Attributes
Utility	Communication Node, Condensation Line, Sanitary Sewer, Steam Line, Telephone Station, <i>Dam</i>	Kilovoltamperes, Radar Reflectivity, Emissivity, IR & NVG, Albedo, <i>Probability to Kill, Radar Cross Section</i>
Boundary	De Facto Boundary, Boundary Marker, Armistice Line, Cease-Fire Line, Cairn, Restricted Airspace, Demilitarized Zone, Software Boundary, Key Tracking Area, Low-Intensity Conflict Area, Sensitivity Area	Length, Width, Height Above Ground, Surface Material, Height Accuracy, Location, Controller of Boundary, Boundary Conditions (i.e., barbed-wire fence), Radar Reflectivity, Emissivity, Albedo, Acoustic/Magnetic/Pressure Properties, <i>IR & NVG</i>

2.4 UVMap

Table 8 presents current and future UVMap requirements not being met by feature class. The feature requirements not met by UVMap primarily occur in the hydrography feature class. The inclusion of hydrography features, such as those found in the DNC, applied to near-coastal, shallow-water areas would meet the requirements of Navy and Marine Corps users for this class. Another identified requirement is for a soil feature class layer that UVMap does not currently contain.

Attribute requirements call for greater detail for all feature classes than UVMap currently contains. One specific example is the requirement for the level of feature detail contained in DFAD. A new group of attribute requirements concerning radar reflectivity and electromagnetic properties (emissivity, IR & NVG, albedo, and electro-optical reflectivity) occurs in all the layers.

3.0 USE OF FEATURE AND ATTRIBUTE INFORMATION

This section highlights the survey's set of current and future feature, attribute, accuracy, and resolution requirements that satisfied the largest number of users. This section details how each feature class was described in the survey.

The analysis shows that the three key feature classes were elevation, hydrography, and boundary. Figure 1 shows the importance placed on these three feature classes by the survey respondents. Primary features for all feature classes were composed of those representing the elevation of landforms, along with features of significant vertical extent. Primary attributes for all the feature classes were those describing the spatial limits (dimensions) of the features.

Feature class requirements in the future will grow significantly, often doubling or more (Figs. 1 through 11). Requirements for improved resolutions are less clear, but there is some evidence that the present typical resolution requirements of approximately 2.5 to 5.0 m will be more stringent—1.0 m—in the future. Certainly the requirements for more databases will increase, as there is a clear increase in requirements for three-dimensional views with true size and orientation.

For areal requirements (Fig. 2), two trends were observed in the responses. Areal extent is defined as “the area over which a typical model or simulation operates.” The most widely used areal extents are 1000 nmi² and areal extents over entire continents. A wide variety of other areal extents is required by various users. The largest group of “others” require larger-than-continent-sized extents: basin, hemisphere, or worldwide coverage. The areal requirements will shift in the

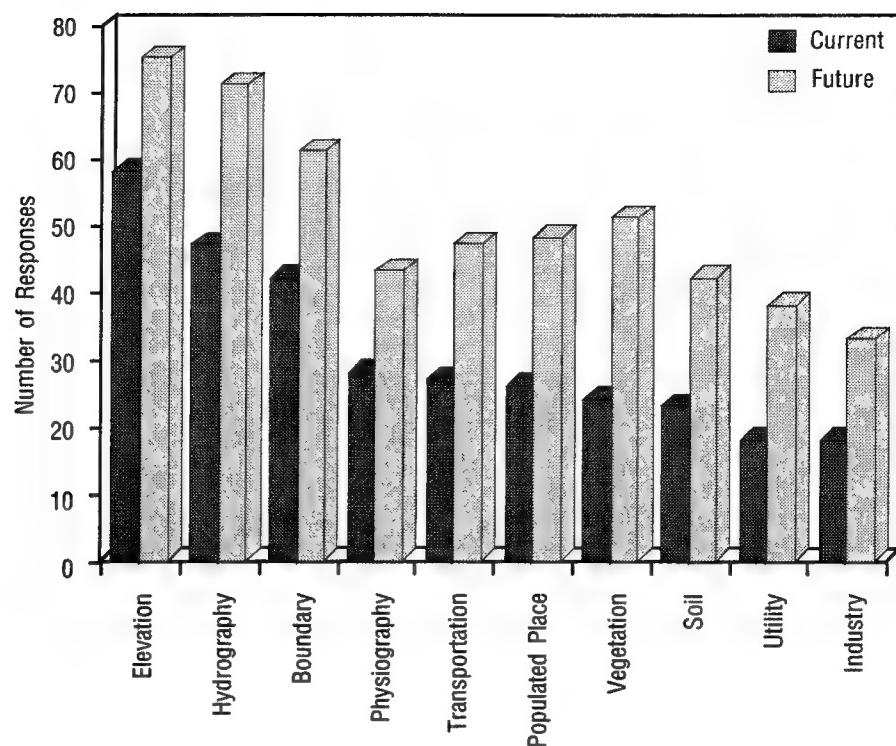
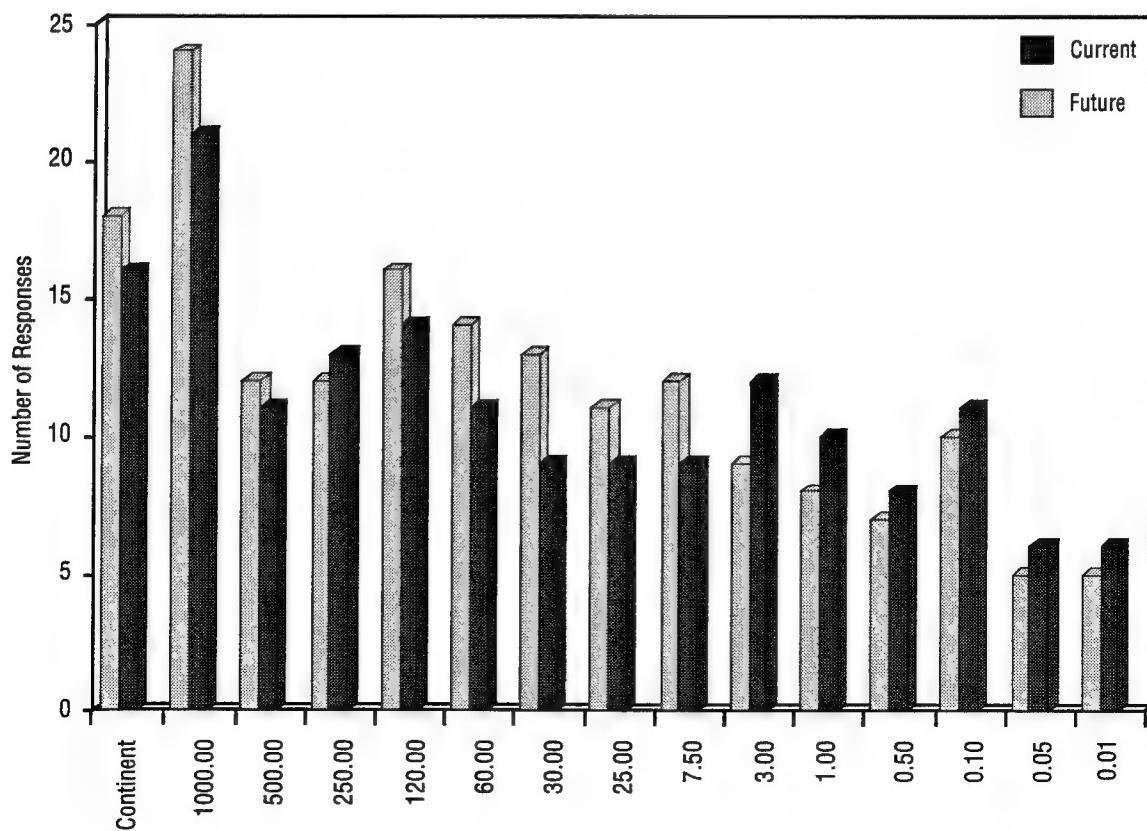


Fig. 1 — Current and future feature class requirements

Fig. 2 — Current and future areal extent requirements in nmi^2

future. The demand for all databases with areal requirements of 3 nmi² or less will increase. At the same time, requirements for databases with areal extents greater than 3 nmi² will decrease. In spite of these demands, the survey data indicate that the areal extents with the most requirements will continue to be 1000 nmi² and entire continents.

For reference datum requirements (Figs. 3 and 4), the most frequently used reference datums are WGS84 and Mean Sea Level.

Nine Navy programs currently use WGS72 and 5 plan to utilize WGS72, but 27 programs do not know their horizontal datum requirement for the current work. Almost that many do not know their horizontal datum requirement for the future. Similar levels of uncertainty are noted for vertical datum requirements. The current usage and planned usage of non-WGS84 datums is of particular concern, since WGS84 is the most accurate and current horizontal datum.

For most commonly required currentness range (Fig. 5), 3 years is the most commonly required. The elevation feature class is more complicated. There, the most commonly required currentness

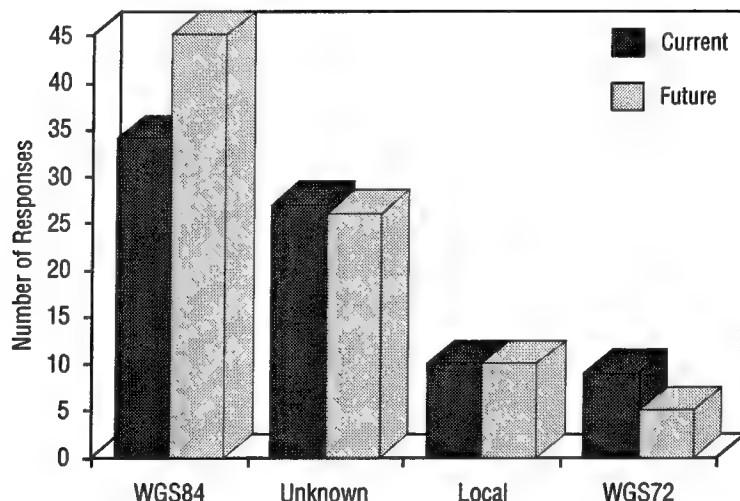


Fig. 3 — Horizontal reference datum

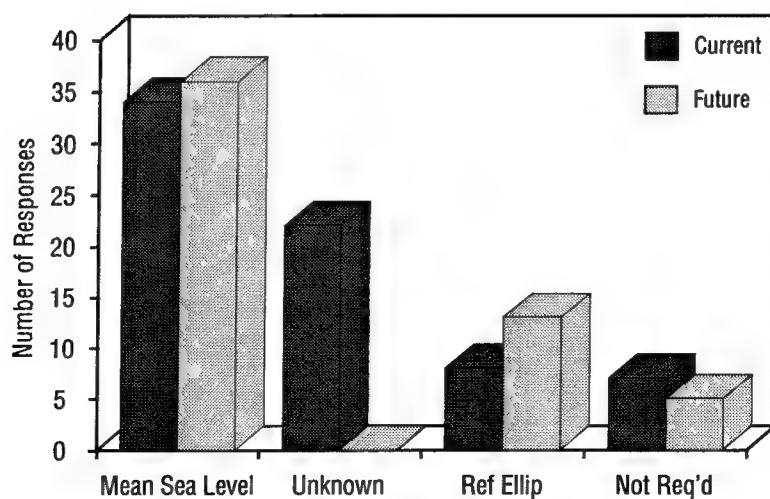


Fig. 4 — Vertical reference datum

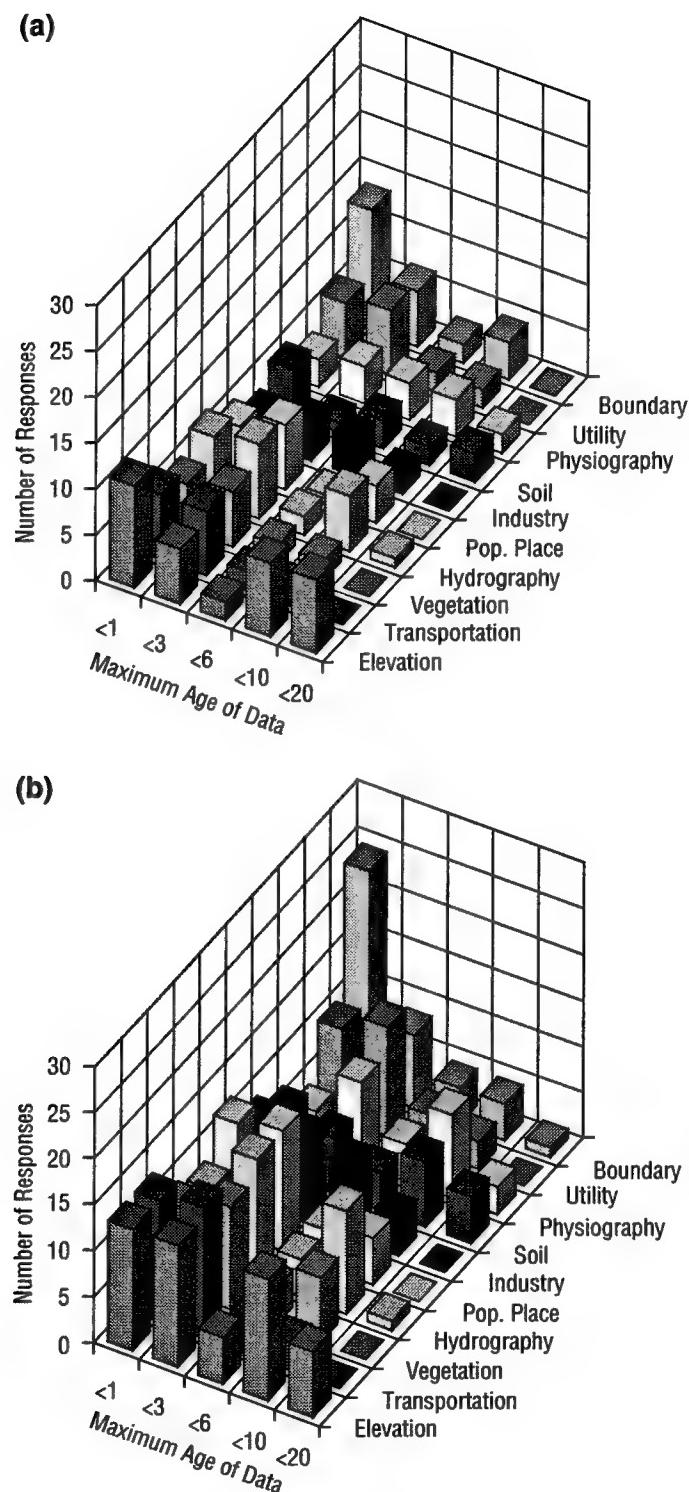


Fig. 5 — (a) Current and (b) future currentness requirements

range is still less than 3 years, but a significant minority of users have a present requirement of less than 20 years. In the future, survey data indicate that a majority of elevation feature class users will still require currentness of less than 3 years. However, in the future, a significant minority of users of the elevation feature class will have a required currentness of less than 10 years.

Each of the 10 feature classes examined in this section has its own unique accuracy and resolution requirements. However, there are lessons to be learned from looking at all feature classes collectively. The current, commonly accepted absolute accuracy requirement in both the vertical and horizontal directions is 5 m. The most commonly required absolute accuracy will remain at 5 m in the future; however, there will be an increase in the requirement for better absolute accuracies. The general shift in horizontal absolute accuracy requirement is toward 5 m. There is also an increase in the requirement for absolute accuracies in the 0.25 to 5.0 m range in the future.

The current commonly accepted relative accuracy requirement in both vertical and horizontal directions is 5–10 m. The future relative accuracy requirement in both the vertical and horizontal directions is 0.5–10.0 m. The larger spread in the future requirements for relative accuracy probably indicates a larger uncertainty in predicting the future.

The required horizontal and vertical resolutions fall into two classes: either very fine resolutions (the most common current horizontal resolution required is 1 m) or relatively coarse resolutions of 50 to 100 m. The most commonly required resolutions will not change in the future, but there will be an increase in higher resolution requirements. More users will be needing resolutions in the 1-m range than they do now.

For absolute horizontal accuracy (Fig. 6), three accuracies are important. The most common absolute horizontal accuracy is 1 to 5 m, with other users grouping around 25 and 1000 m. In the future, many of the users who presently require 25-m absolute horizontal accuracy will move toward the 5- to 10-m accuracy requirement. The 1000-m requirement will stay the same, and the importance of the 5- to 10-m accuracy requirement will be increased.

For relative horizontal accuracy (Fig. 7), the range of both current and future requirements is broad. Current requirements peak around 10 m, and more users require small relative accuracies than large relative accuracies. More stringent relative accuracies increase somewhat in the future, but the peak will remain around 10 m.

For horizontal feature resolution (Fig. 8), 1 m is currently the most common. A secondary peak in the current relative horizontal resolution occurs at 50 m. The future requirements are similar except for a significant increase in resolution requirements in the range of 1 to 15 m.

For distance over which this accuracy is required (Fig. 9), 500 m is currently the most common. There will be no significant change in the future.

For absolute vertical accuracy (Fig. 10), 5 m is currently the most common. The trend is toward improved accuracy, with a secondary peak in requirements at 1 m. Requirements for a vertical accuracy greater than 15 m are relatively few. Absolute vertical accuracy requirements generally will increase in the future, and the most common future requirement is in the range of 1.0 to 2.5 m.

For relative vertical accuracy (Fig. 11), 1 m is currently the most common. There are few requirements for a current relative vertical accuracy greater than 10 m. A broad range of current requirements is from 0.05 to 10.0 m, with a peak at around 1 m. Changes in relative vertical accuracy

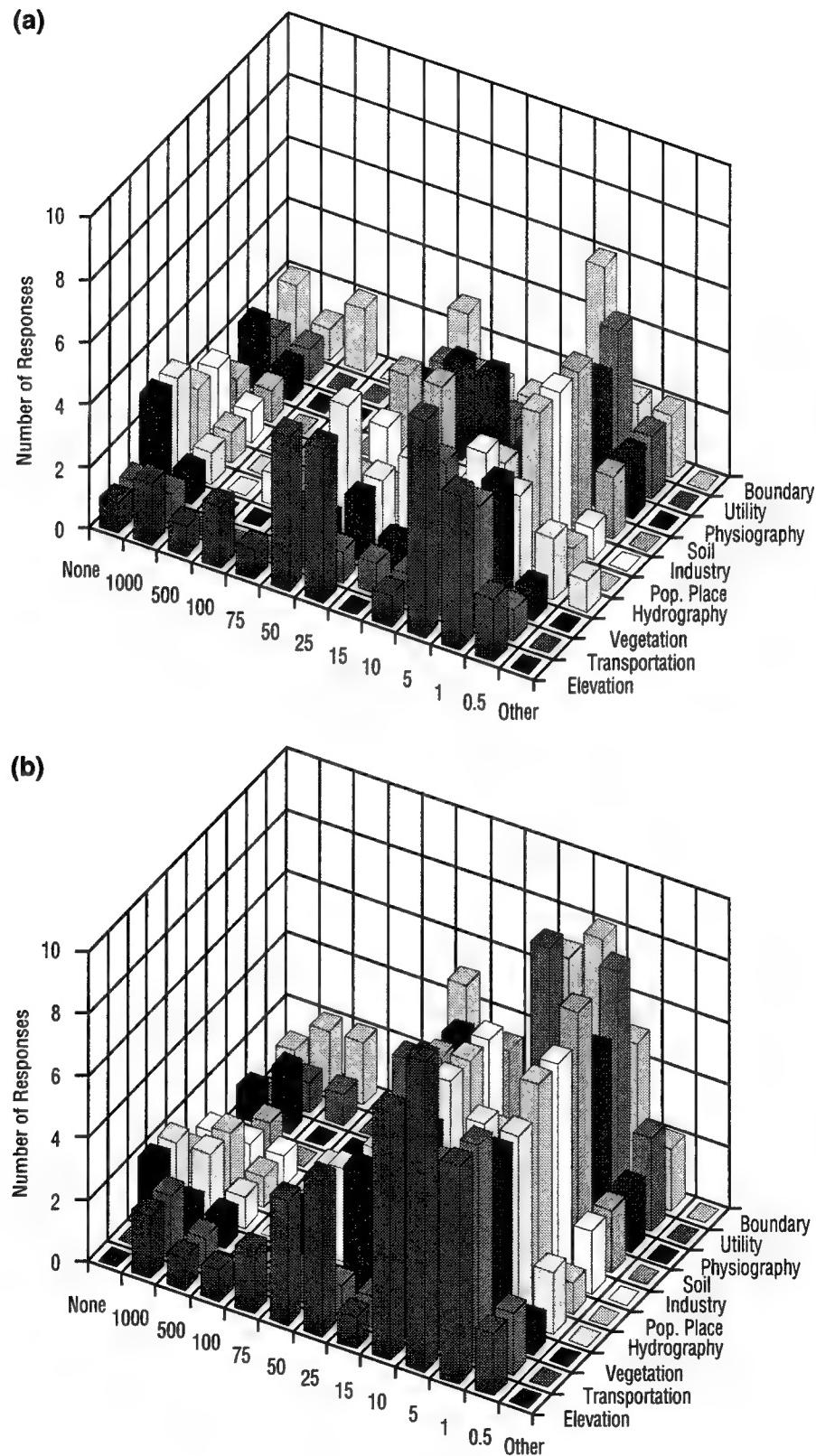


Figure 6 — (a) Current and (b) future absolute horizontal accuracy

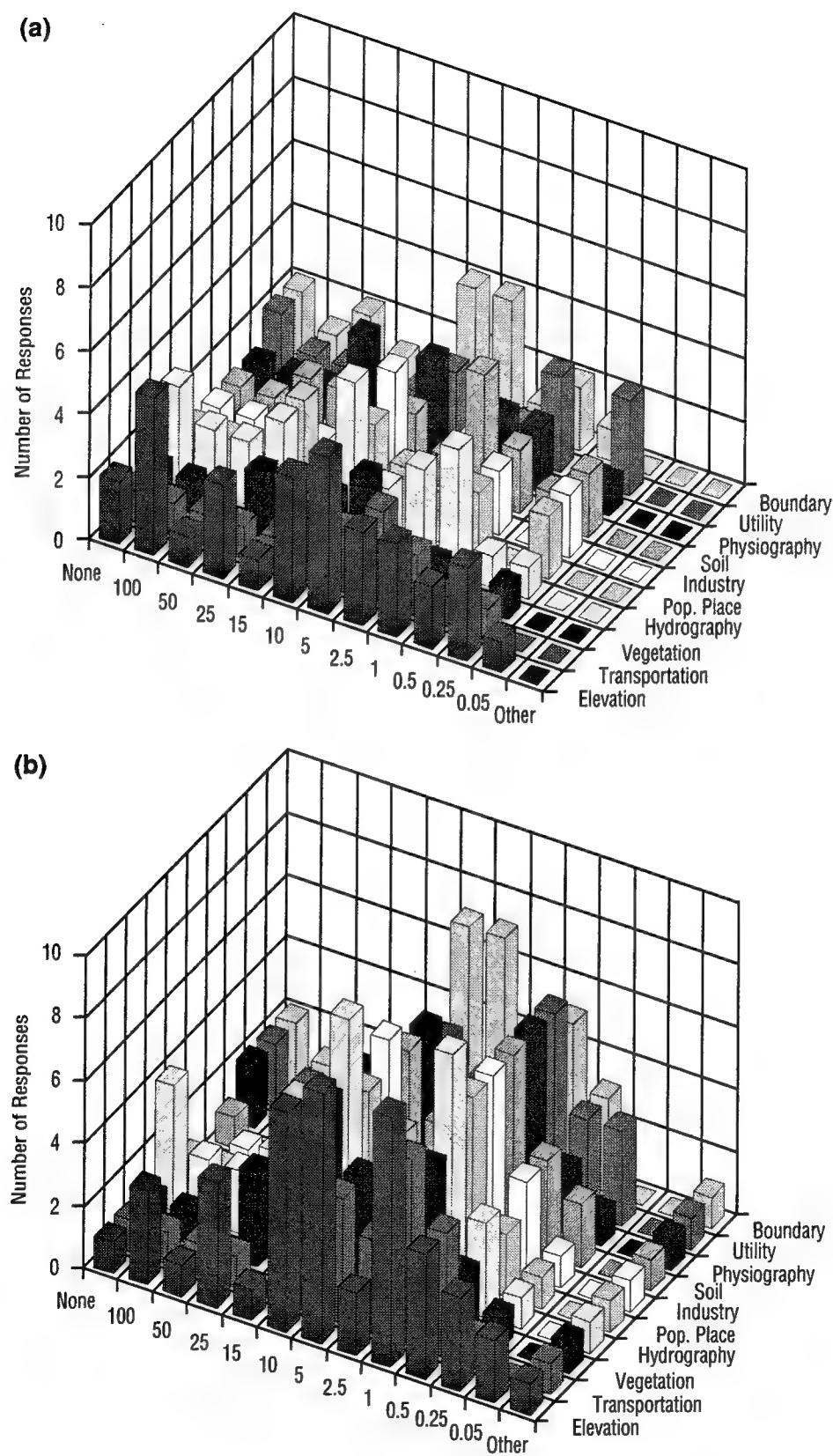


Fig. 7 — (a) Current and (fb) future relative horizontal accuracy

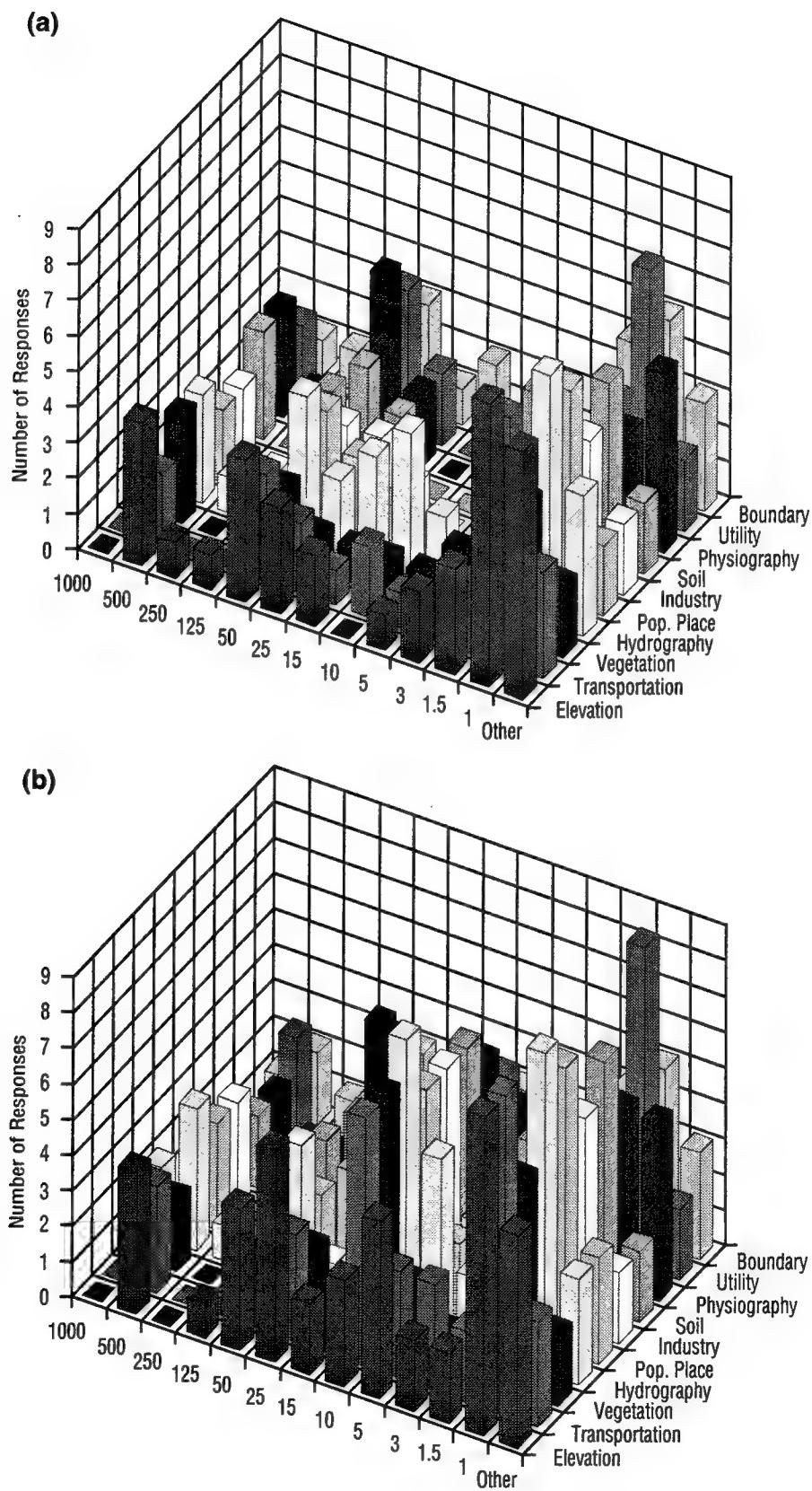


Fig. 8 — (a) Current and (b) future resolution for horizontal features

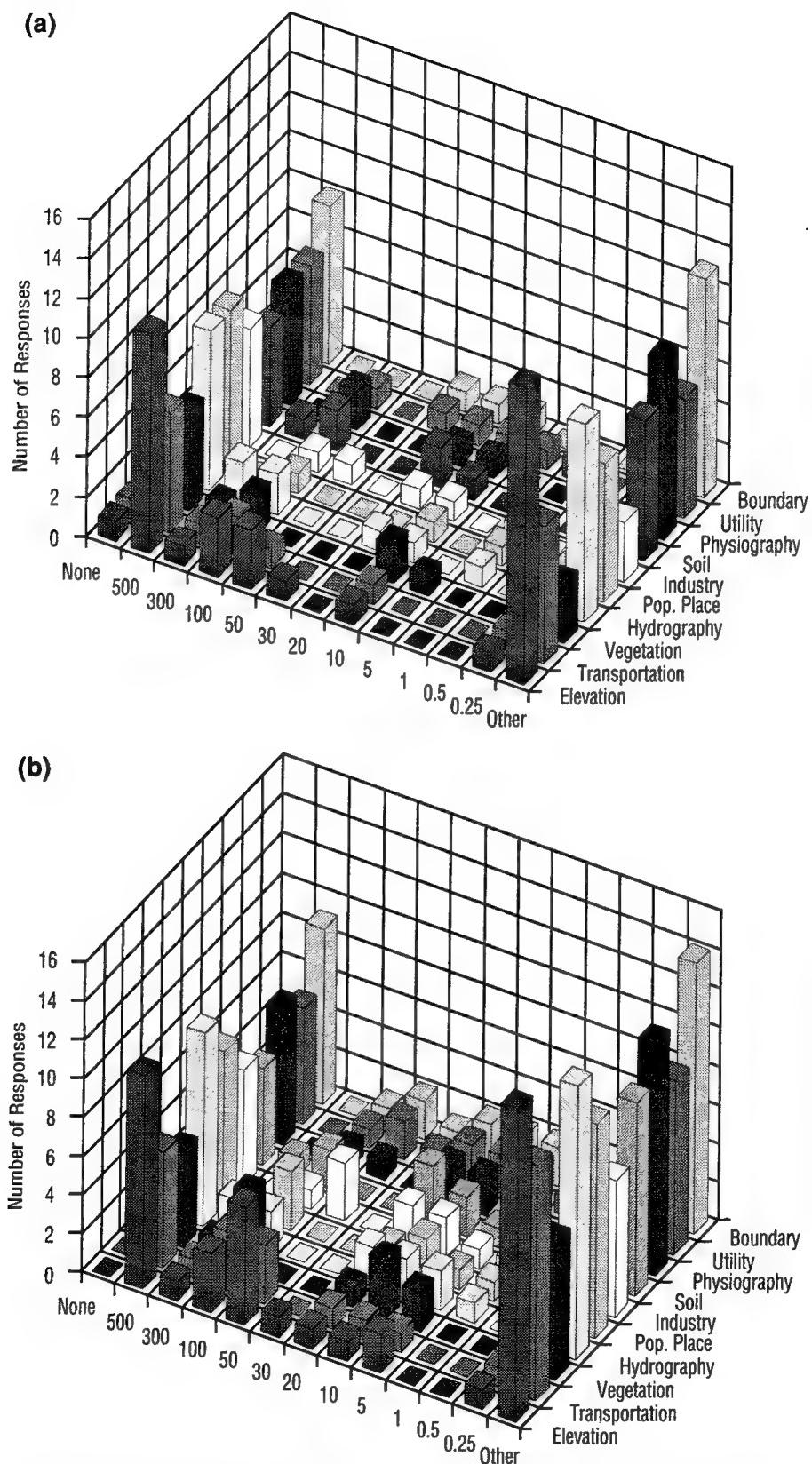


Fig. 9 — (a) Current and (b) future horizontal distance over which the required horizontal accuracy must be maintained

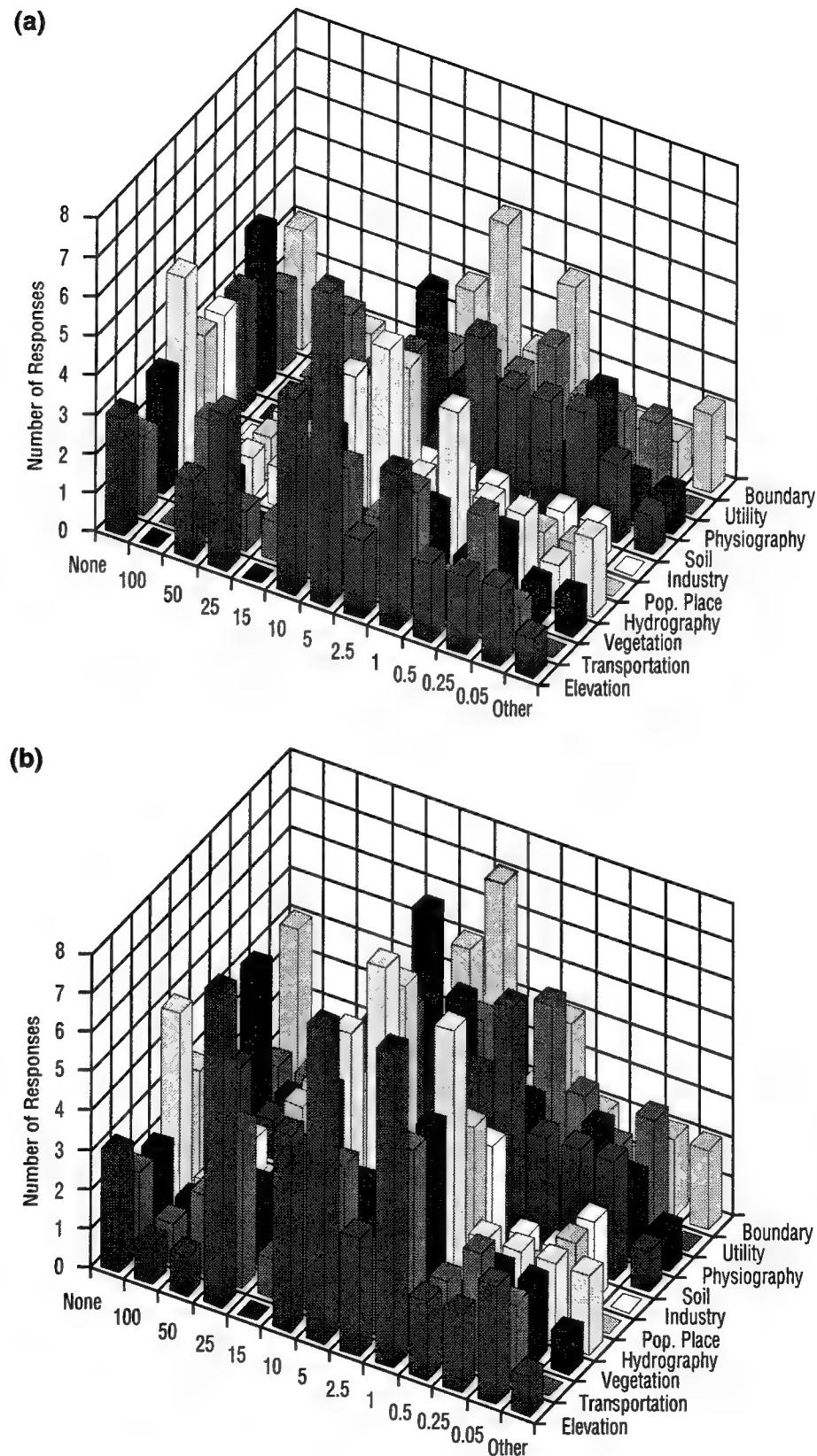


Fig. 10 — (a) Current and (b) future absolute vertical accuracy

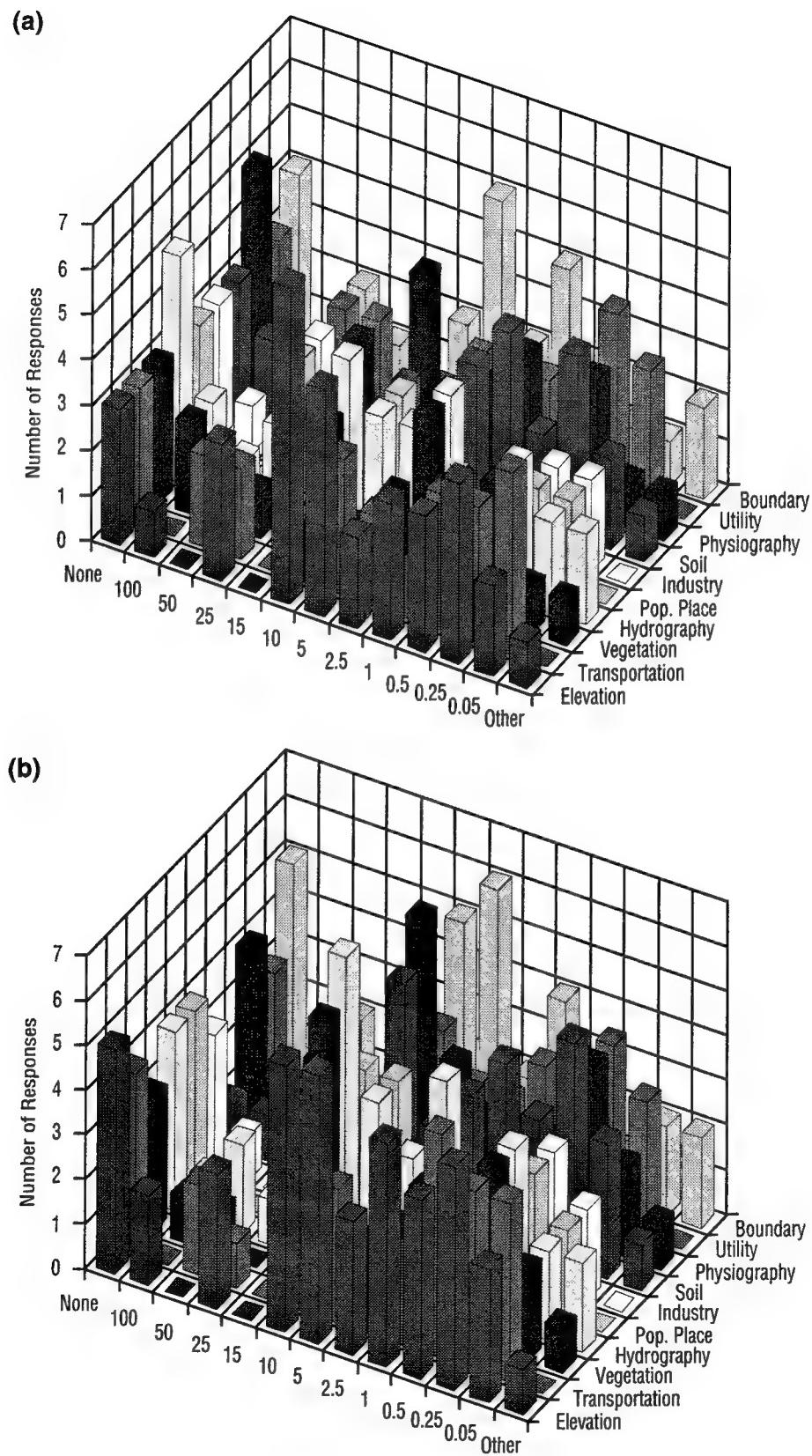


Fig. 11 — (a) Current and (b) future relative vertical accuracy

requirements are not significant in the future except for an increase in the number of requirements for many feature classes.

For resolution of vertical features (Fig. 12), 3 m is the most common. A second set of current requirements is in the range of 50 to 100 m. Changes in vertical feature resolution requirements in the future are not significant.

For geographic relationships (topography) (Fig. 13), the requirement is broad and even and will not change in the future. Stacked on/under topology has a slight lead in popularity.

For feature display requirements (Fig. 14), there is a dominant current requirement for displaying features in true relative size and orientation. This requirement will impose additional database requirements, as each object must be recorded with both a size and an orientation. This requirement is based on anticipation of substantially increased computer power in the future as the requirement for true size and orientation precludes advance calculation of object details or their display. The alternatives, standard objects or icons, impose fewer data collection and storage requirements on the databases. This will not change in the future.

For display dimensions requirements (Fig. 15), two- and three-dimensional displays are approximately equal. In the future this will change drastically because three-dimensional displays will dominate the requirements.

For elevation feature class (Figs. 16 through 18), the most required current display method is, by far, with *contour lines*. The implication is that a robust standard method of producing contours from elevation point data will be useful. The elevation attributes are as expected, contour interval labels (height) are most important, and accurate labels are almost as important. The most commonly required current interval is 100 m. This requirement will not change in the future.

For transportation feature class (Figs. 19 and 20), the key current feature requirements are *roads*, *bridges*, *aircraft facilities*, and *aircraft facility beacons*. There will be large increases in requirements for transportation features in the future, with *roads*, *aircraft facilities*, and *harbor facilities* (piers, anchorages, and dry docks) showing the largest increase. The most important attributes for transportation features are dimensions.

For vegetation feature class (Figs. 21 and 22), the current requirements are approximately constant across all features surveyed. *Trees* are the most important feature; their requirements will approximately double in the future, and no single feature will dominate the requirements. The most important attributes of the vegetation feature class are dimensions.

For hydrography feature class (Figs. 23 and 24), the current requirements will increase significantly in the future. The largest increase (30 users) will be for *shipping channels*; however, there will be significant increases for all surveyed requirements. The two features that show the largest increase are *shipping channels* and *rivers*; their most important attributes are dimensions.

For populated place feature class (Figs. 25 and 26), the most important current requirements are *buildings* and *built-up areas*, reflecting the need to map the locations of population concentrations. Features that contain a large amount of open space, such as *parks* and *athletic fields*, are also important and become even more so in the future. The most important attributes of these features are dimensions.

For industry feature class (Figs. 27 and 28), the current requirements will approximately double in the future. *Industrial plants*, *towers*, and *storage tanks* are the most important requirements for

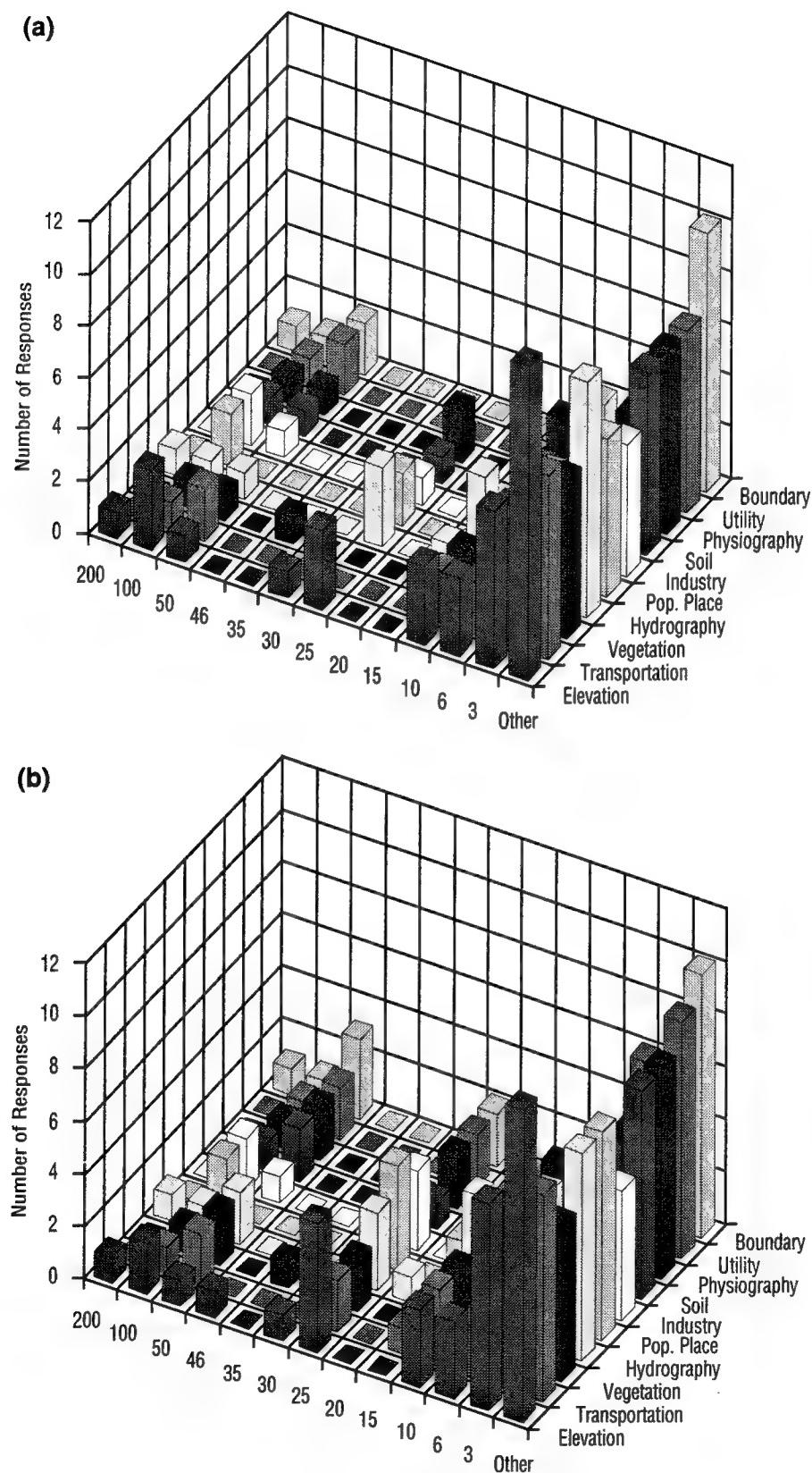


Fig. 12 — (a) Current and (b) future vertical resolution requirements

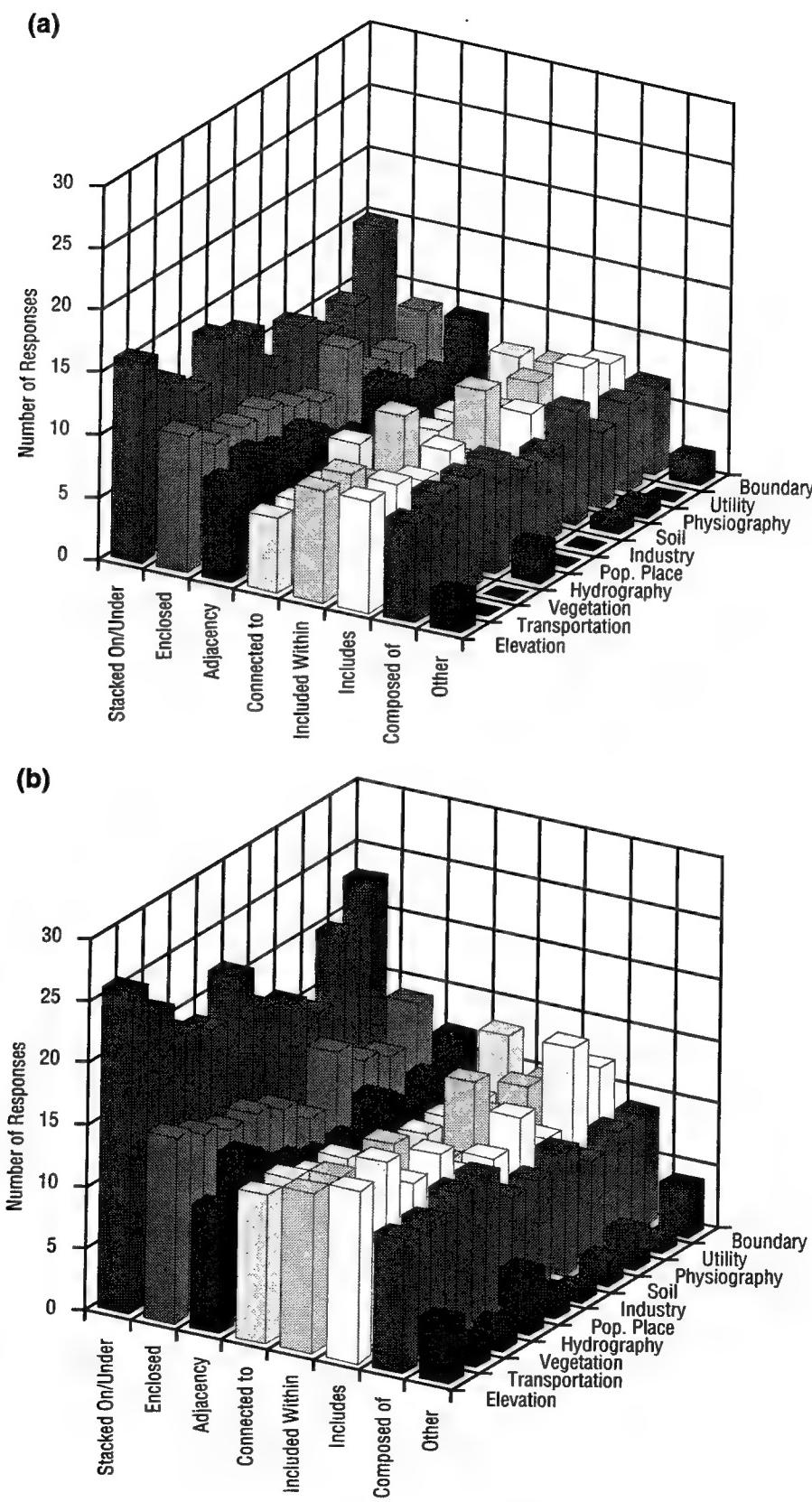


Fig. 13 — (a) Current and (b) future geographic relationships

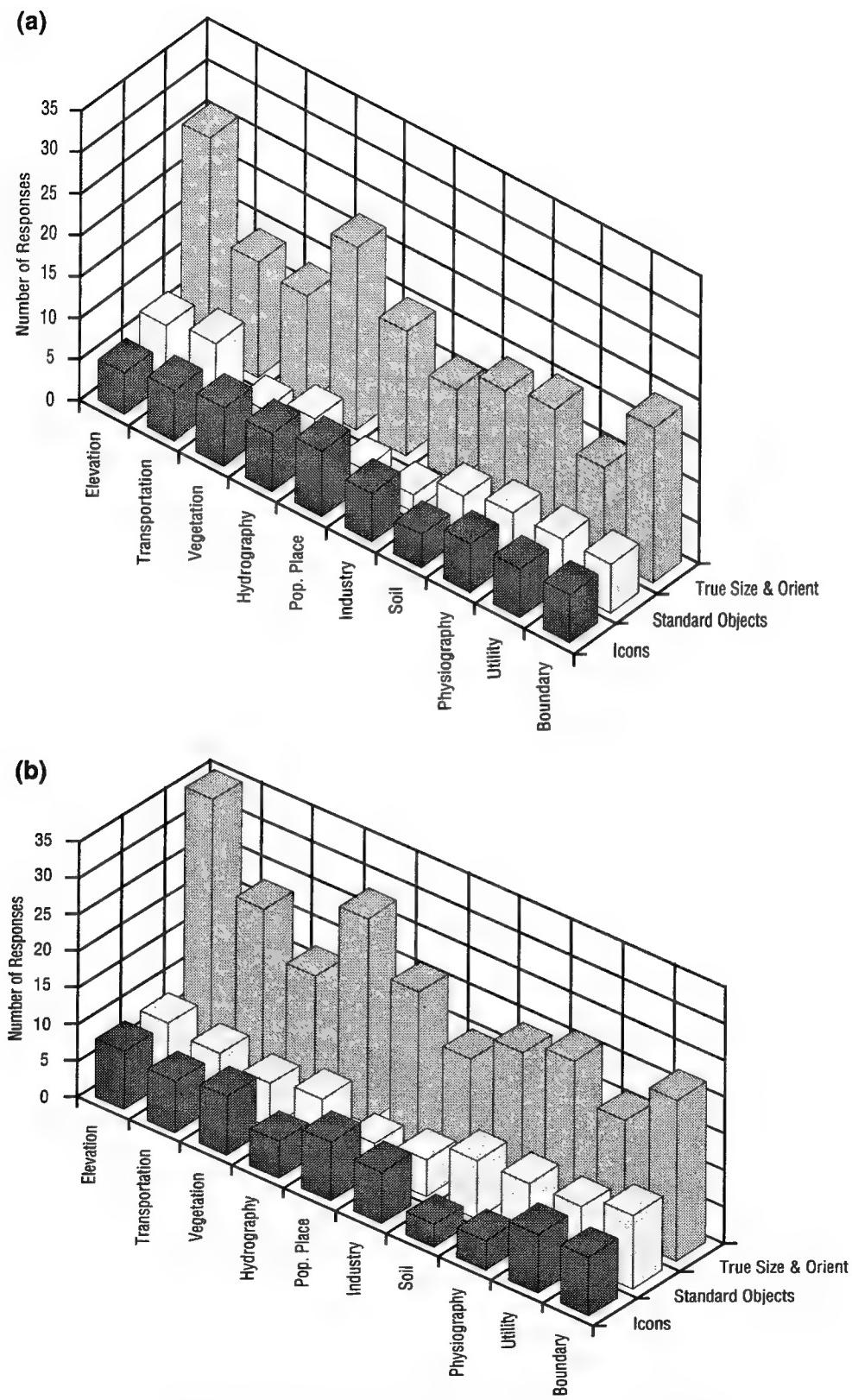


Fig. 14 — (a) Current and (b) future feature display requirements

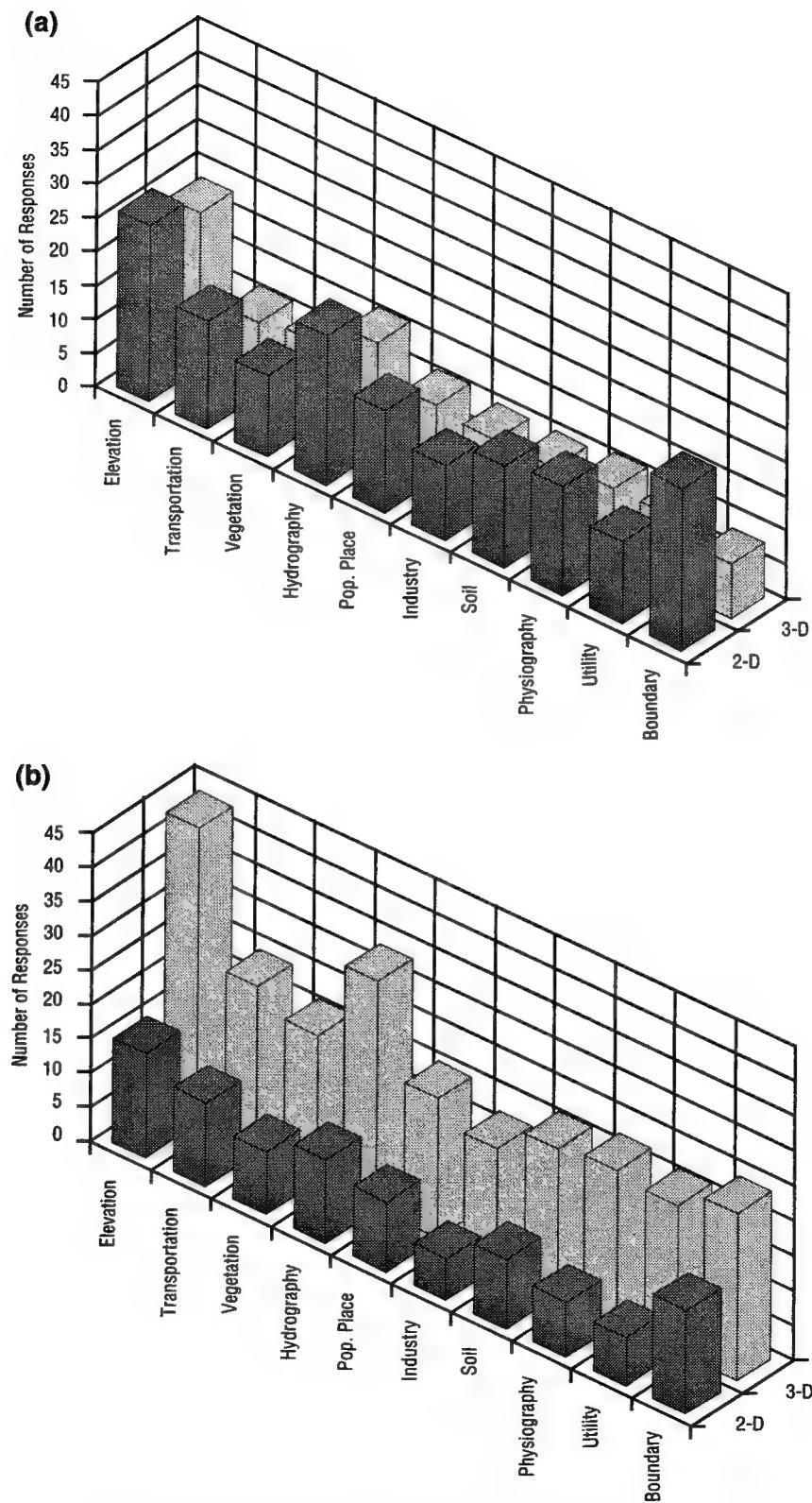


Fig. 15 — (a) Current and (b) future display dimension requirements

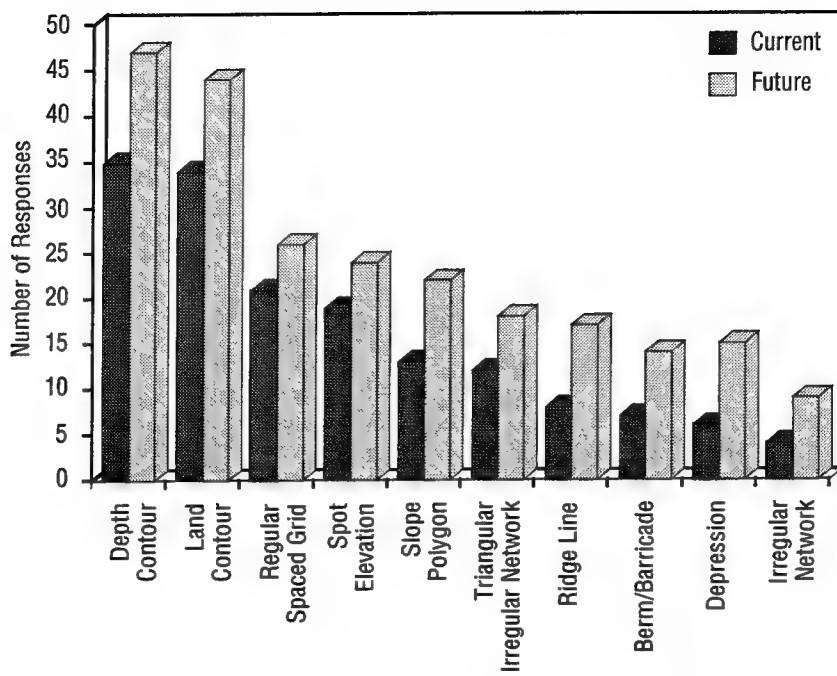


Fig. 16—Current and future elevation feature requirements

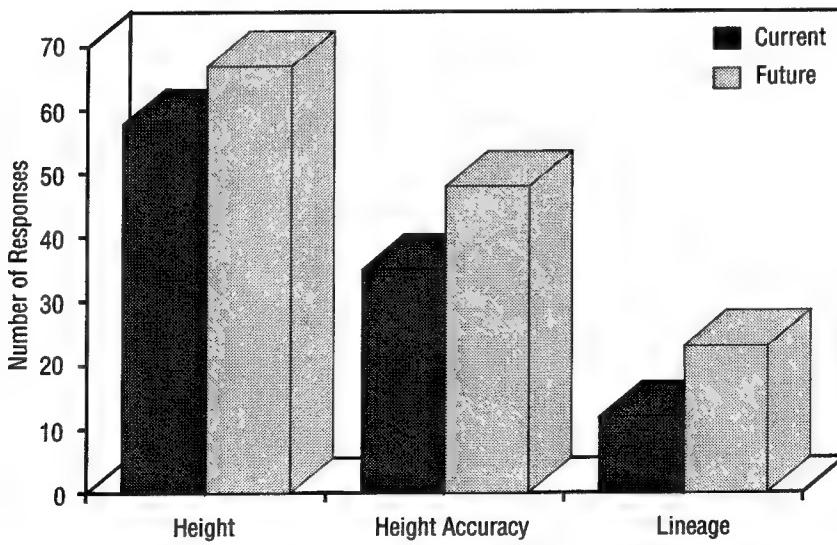


Fig. 17—Current and future elevation attribute requirements

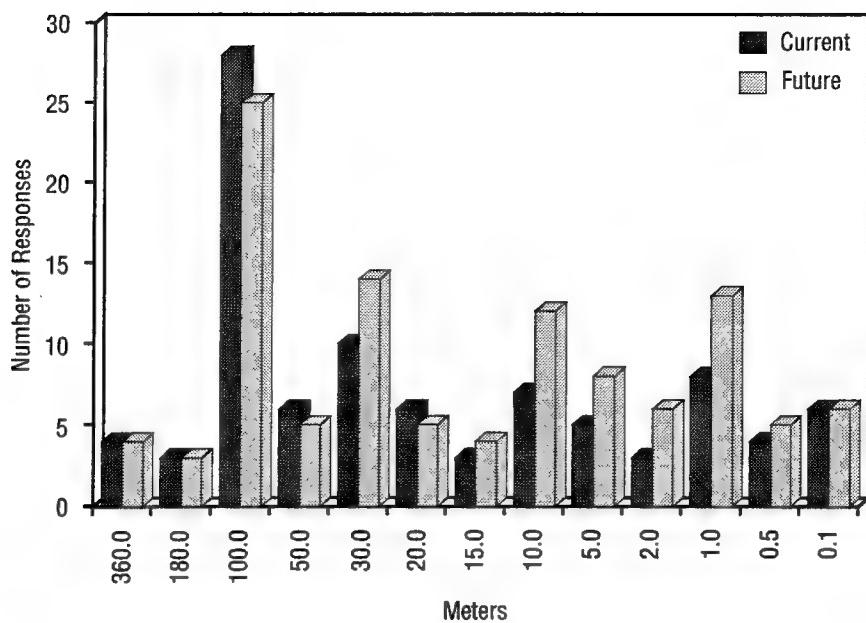


Fig. 18 — Current and future elevation contour interval requirements

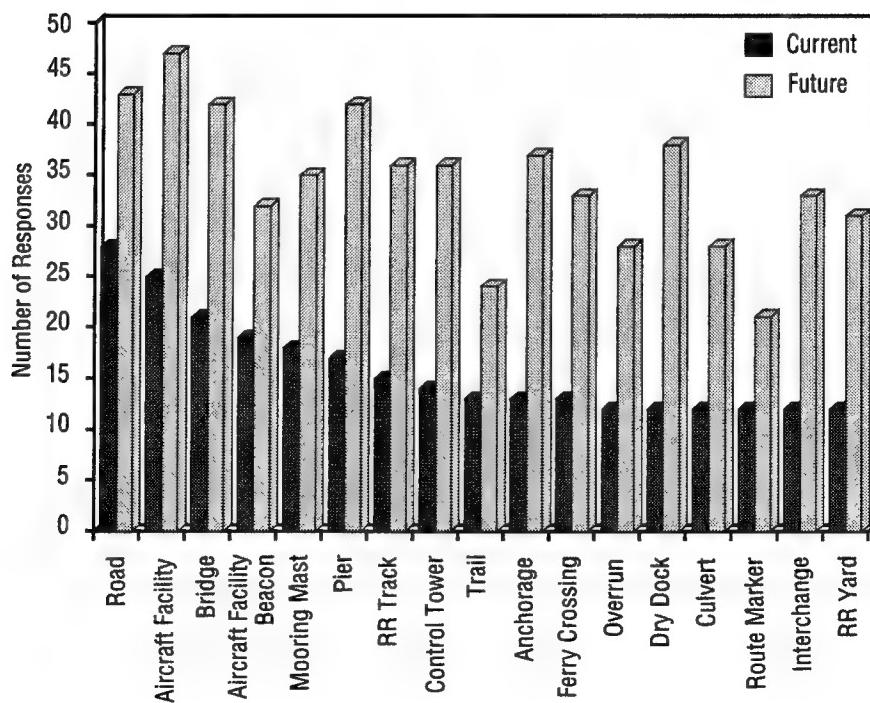


Fig. 19 — Current and future transportation feature requirements

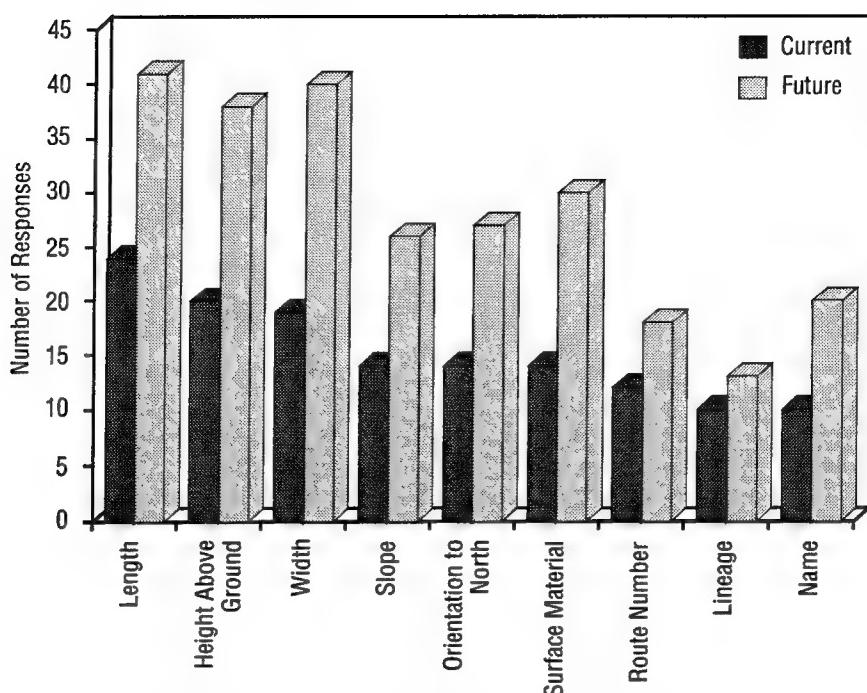


Fig. 20 — Current and future transportation attribute requirements

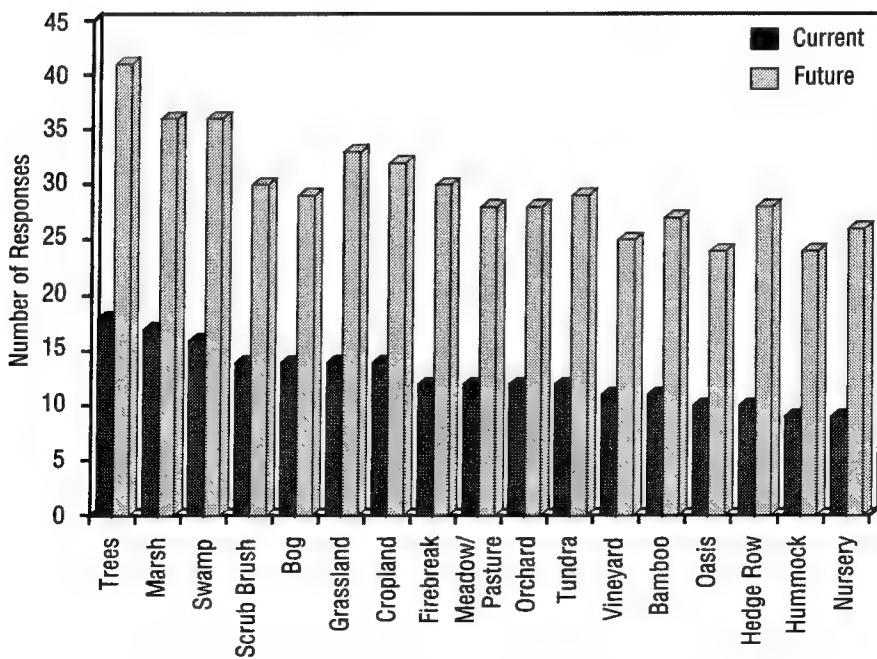


Fig. 21 — Current and future vegetation feature requirements

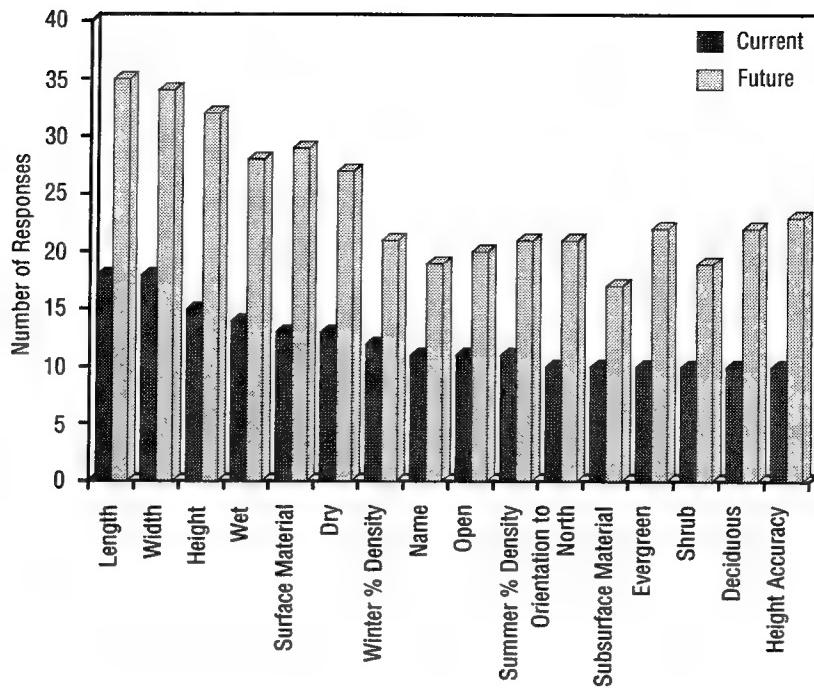


Fig. 22 — Current and future vegetation attribute requirements

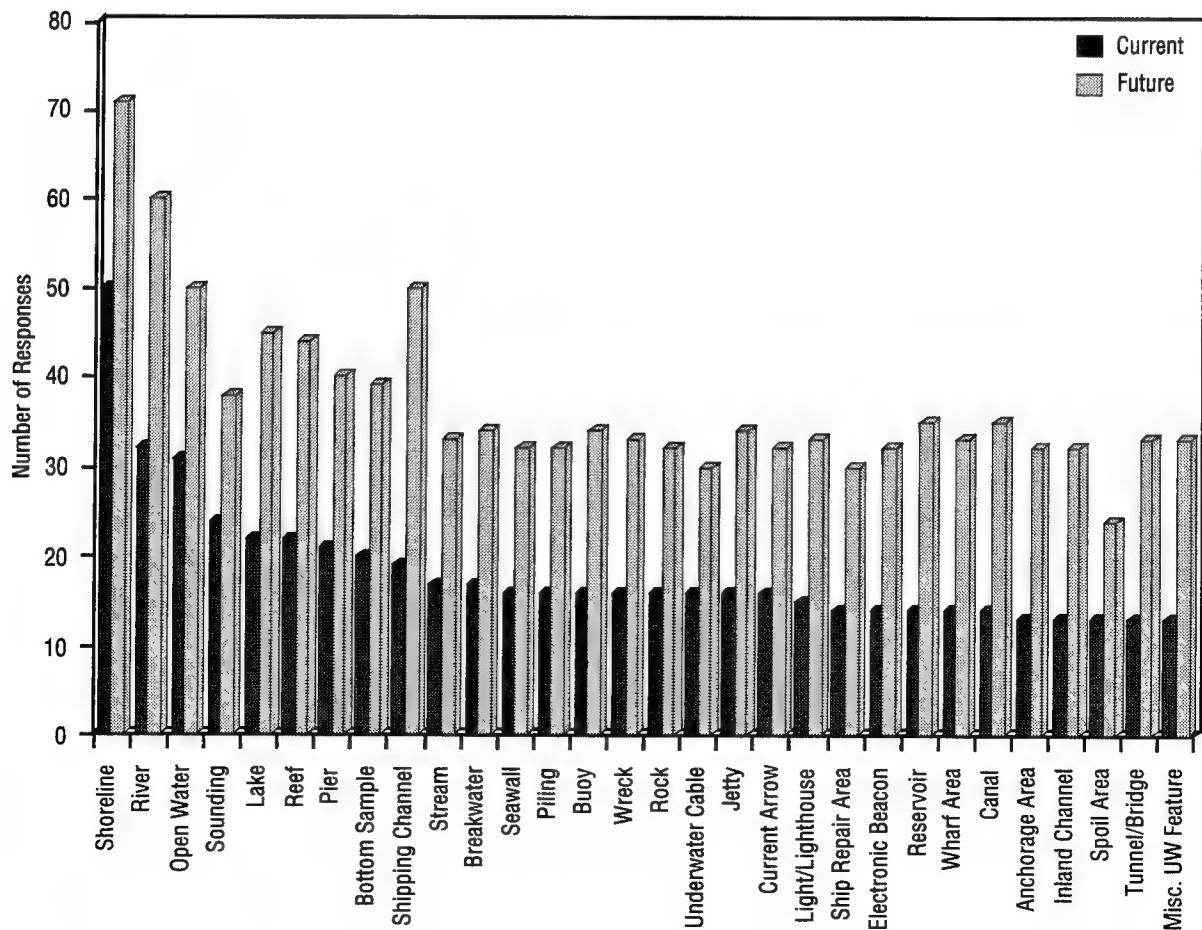


Fig. 23 — Current and future hydrography feature requirements

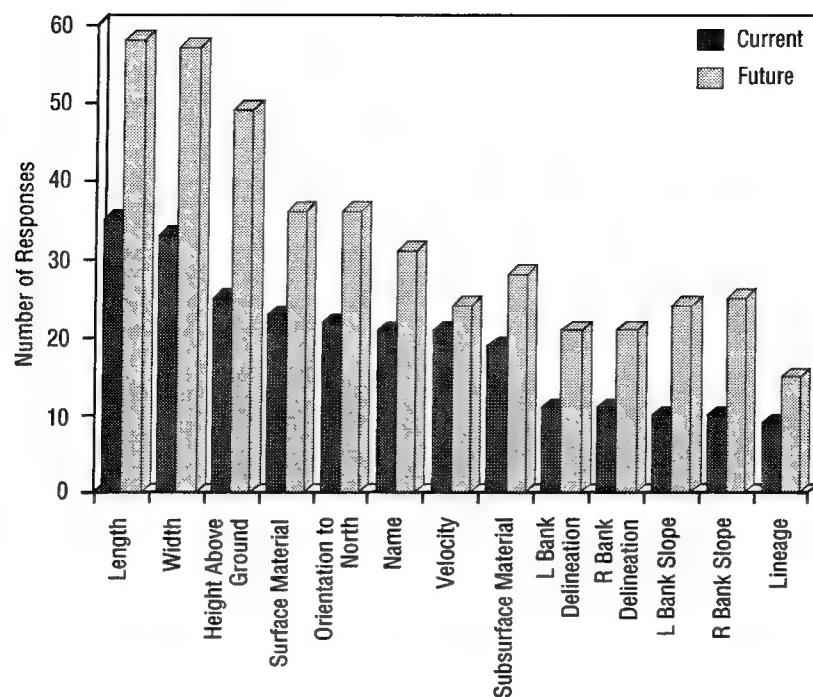


Fig. 24 — Current and future hydrography attribute requirements

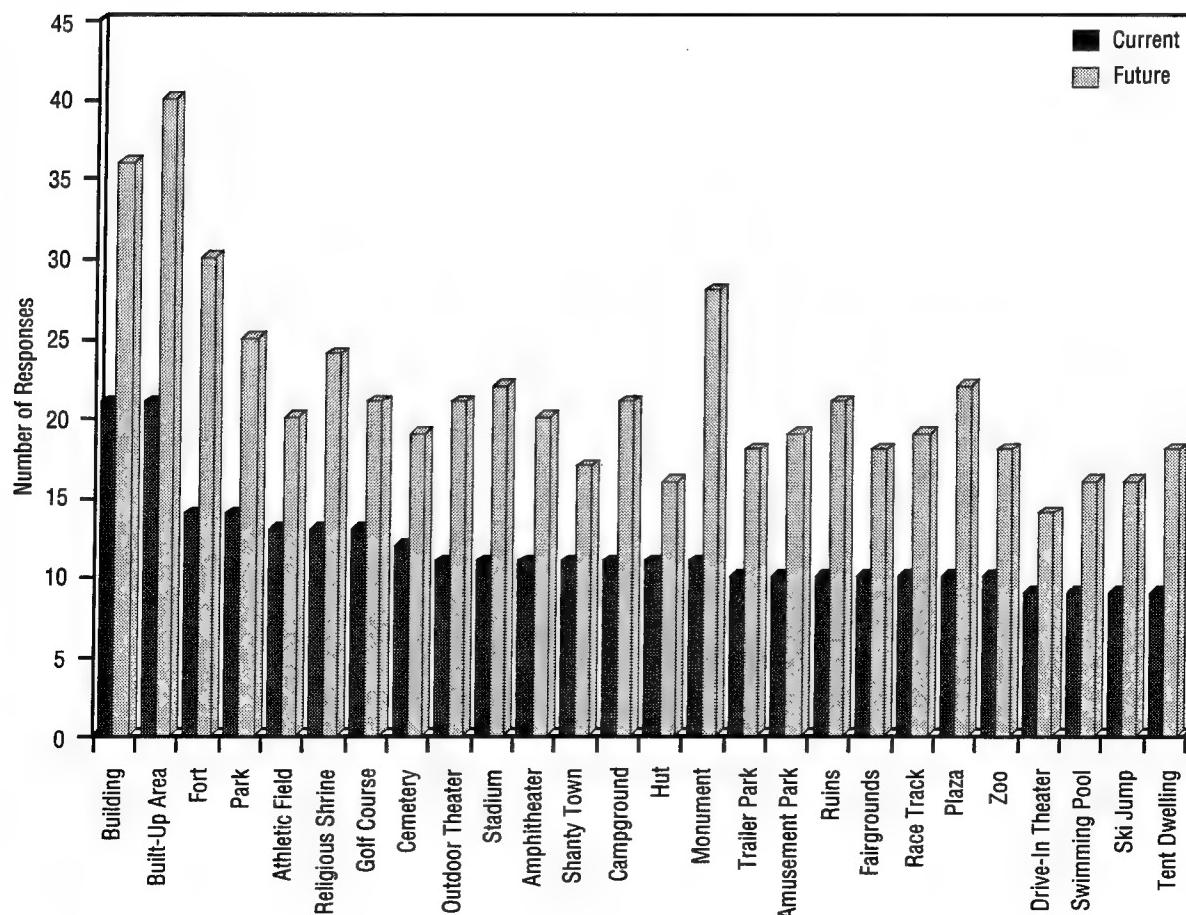


Fig. 25 — Current and future populated place feature requirements

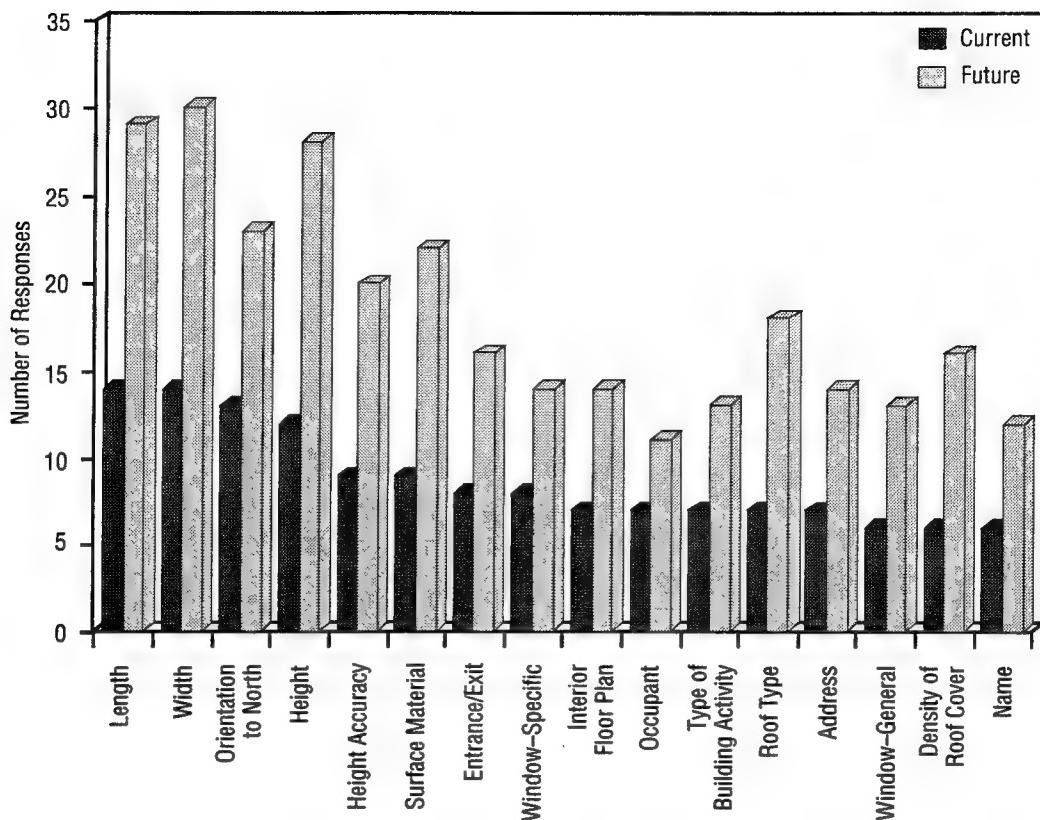


Fig. 26 — Current and future populated place attribute requirements

this feature class. Features that are tall compared to their surroundings are the most important. For example, the single most important feature in the future will be *chimneys/smokestacks*. The most important attributes for these features are dimensions.

For soil feature class (Figs. 29 and 30), all features are currently equally important. All attributes are also approximately equally important. *Sand* is the most frequently requested feature and *peat* is the least frequently requested feature. Twenty-five responded that *sand* is important and 19 responded that *peat* is important. The attributes material composition and roughness show the biggest increases in the future.

For physiography feature class (Figs. 31 and 32), the current most important feature is *islands*. In general, the next most important features are polar features, such as *pack ice*, *polar ice*, and *ice shelves*. Perhaps because this feature class is the only place where polar features were listed, these features were selected more frequently than others in this feature class. The features that show the largest increases in the future are *islands*, *polar conditions*, and *sand dunes*. The most important current and future attributes are dimensions.

For utility feature class (Figs. 33 and 34), the current requirements will approximately double in the future. The most important current feature is *power plants* and *power transmission lines*; the other features are currently approximately equally important. The most important attributes are dimensions.

For boundary feature class (Figs. 35 and 36), the current most important features are *coastal shorelines* and *administrative boundaries*. The most important attributes are dimensions. Temporary boundaries and physical demarcations (*walls* and *fences*) are less important.

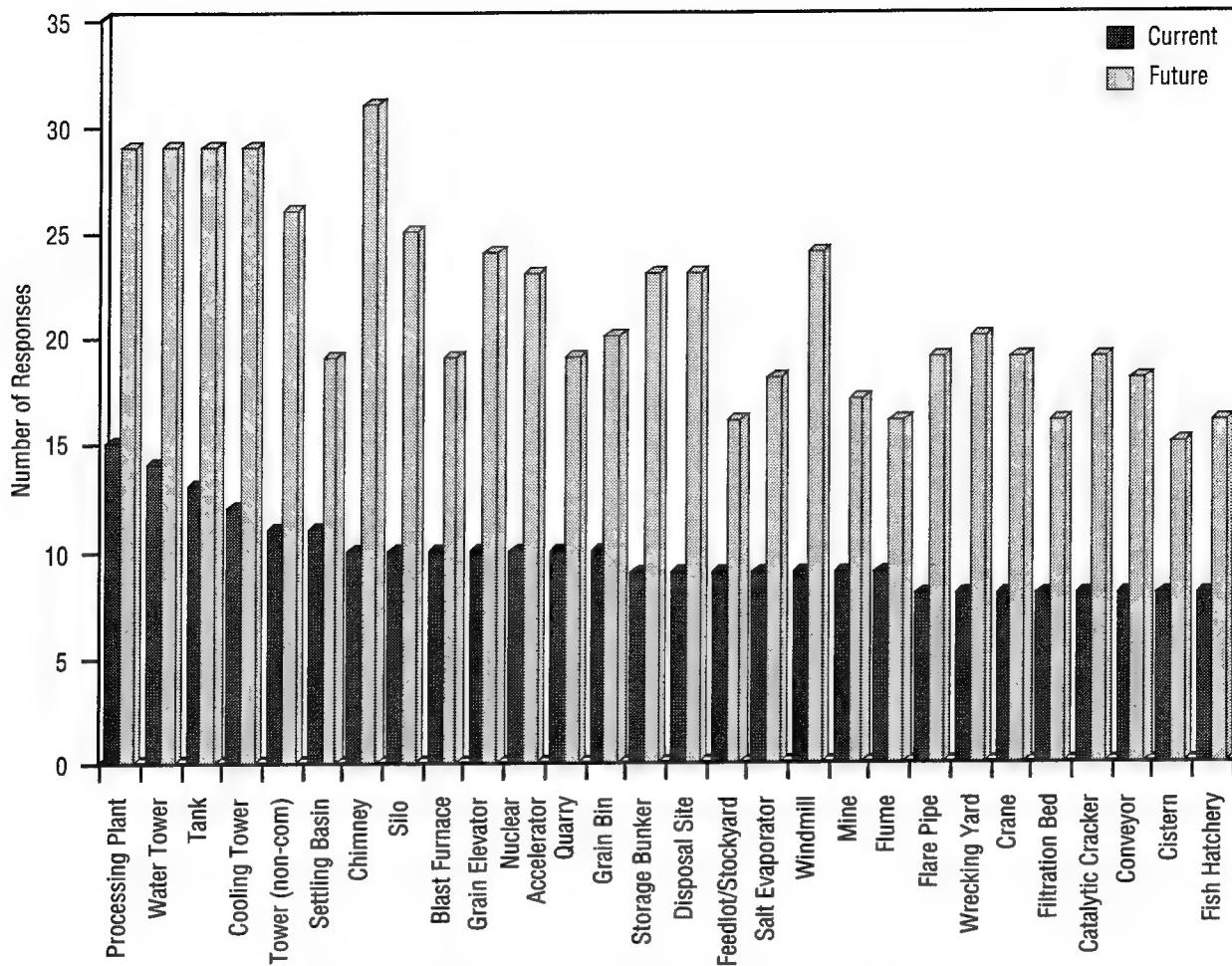


Fig. 27 — Current and future industry feature requirements

3.1 Accuracy and Resolution Summary for Key Features

Each feature class had several features (called *key features*) that are most frequently required. The criteria for deciding which features are key features is based on the change in the number of responses (current) from feature to feature. Usually, the number of responses distinctly lowers after the first few most popular features. Table 9 lists the key features, along with the feature class and the number of responses for the feature. This table is a summary of all feature classes.

Table 10 shows how the feature classes group together, depending on the number of respondents that have a requirement for these feature groups. A total of 11 users currently require at least 8 of the 10 feature classes; this will more than double to 26 users in the future. The most important currently required feature class is elevation. Table 10 shows how many users need elevation along with some other feature class. Elevation, boundary, hydrography, and populated place all had more than 30 current users. Table 10 also shows how important certain combinations of feature classes are to the users. Between features, the ‘...’ indicates a minimum of elevation, one or two other feature classes, and any other feature class combination; the ‘,’ represents only the features noted.

Table 11 lists required features that were not specifically written into the questionnaire. A wide variety of features is required by the users. The ID number refers to the specific program that

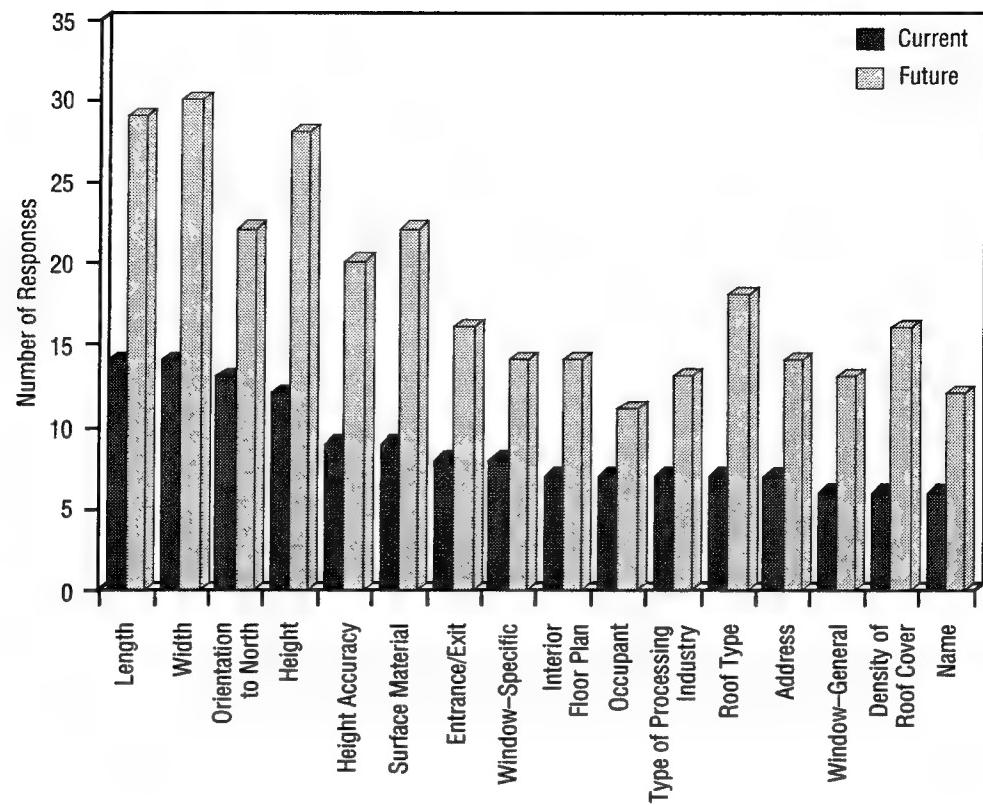


Fig. 28 — Current and future industry attribute requirements

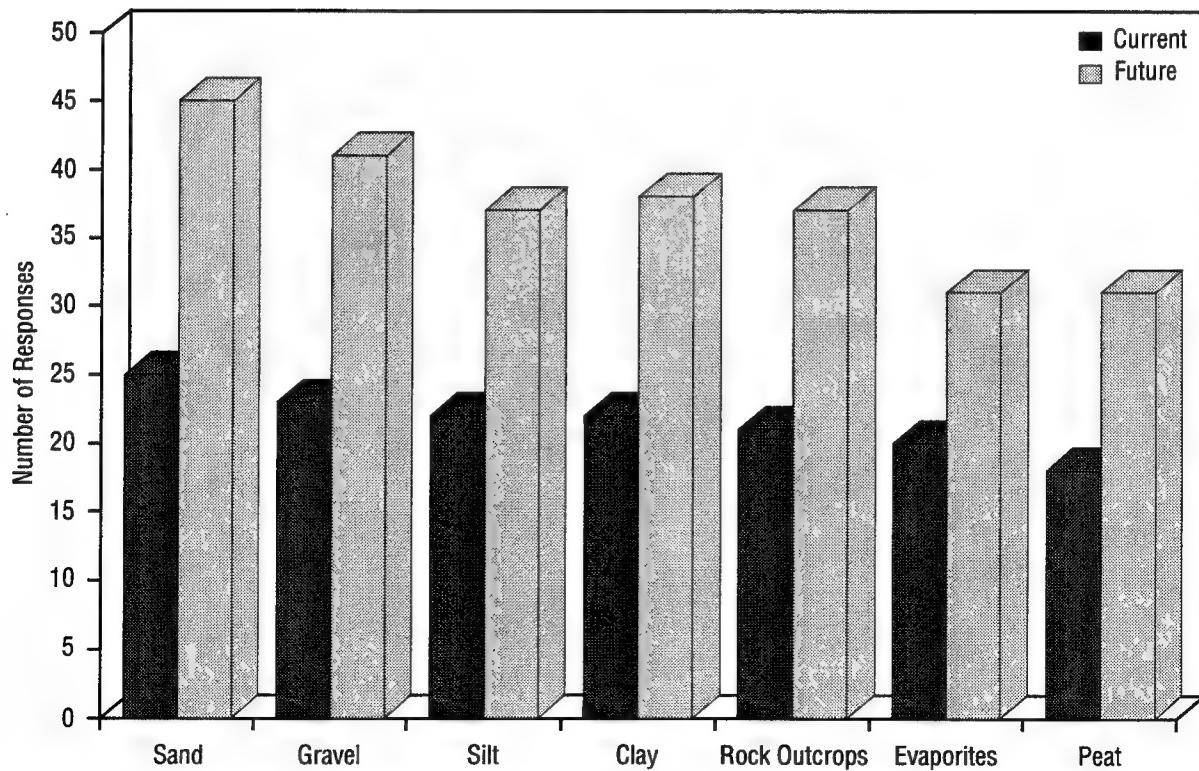


Fig. 29 — Current and future soil feature requirements

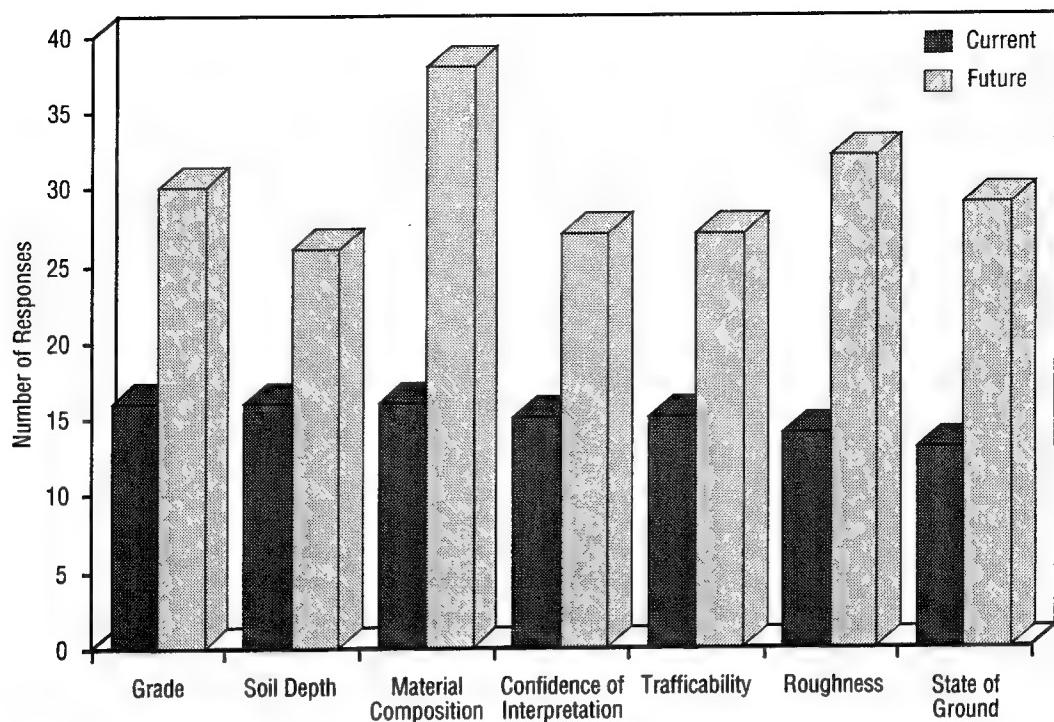


Fig. 30 — Current and future soil attribute requirements

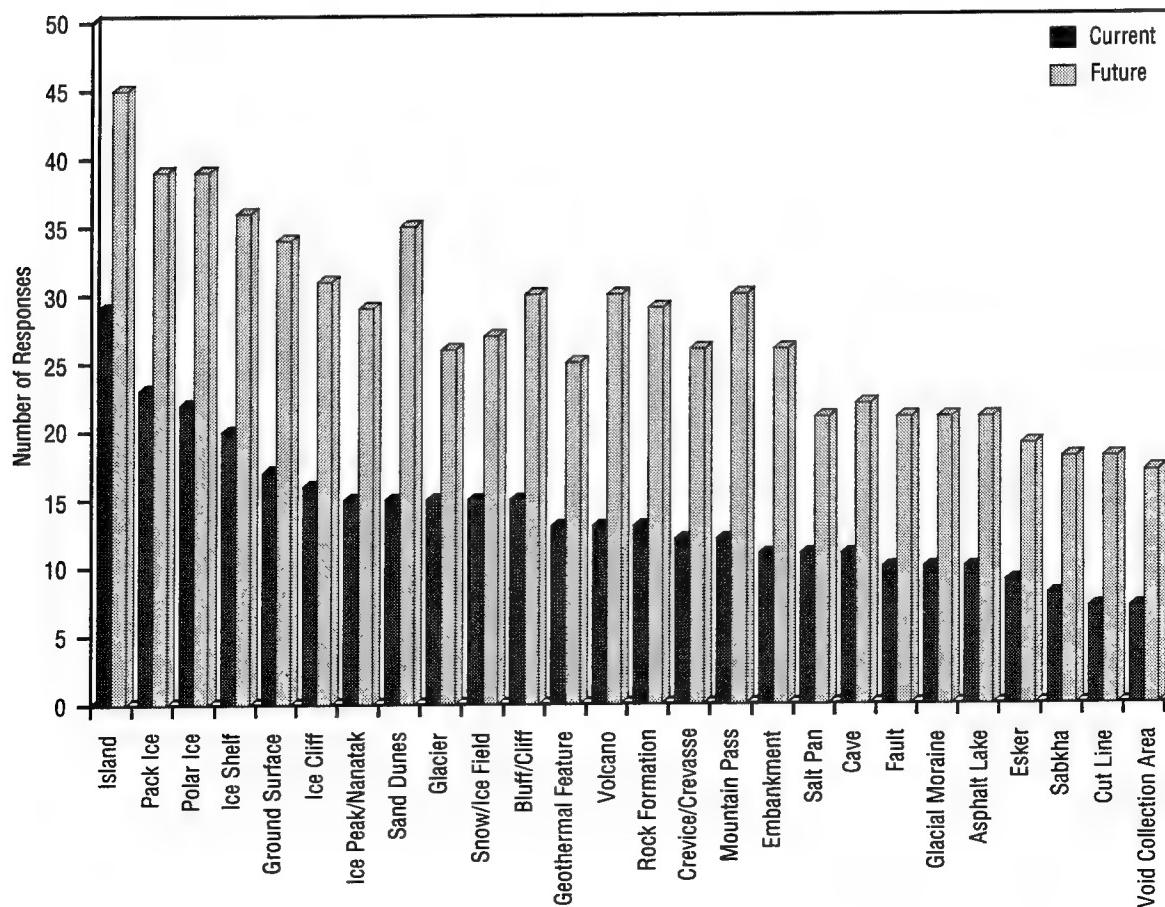


Fig. 31 — Current and future physiography feature requirements

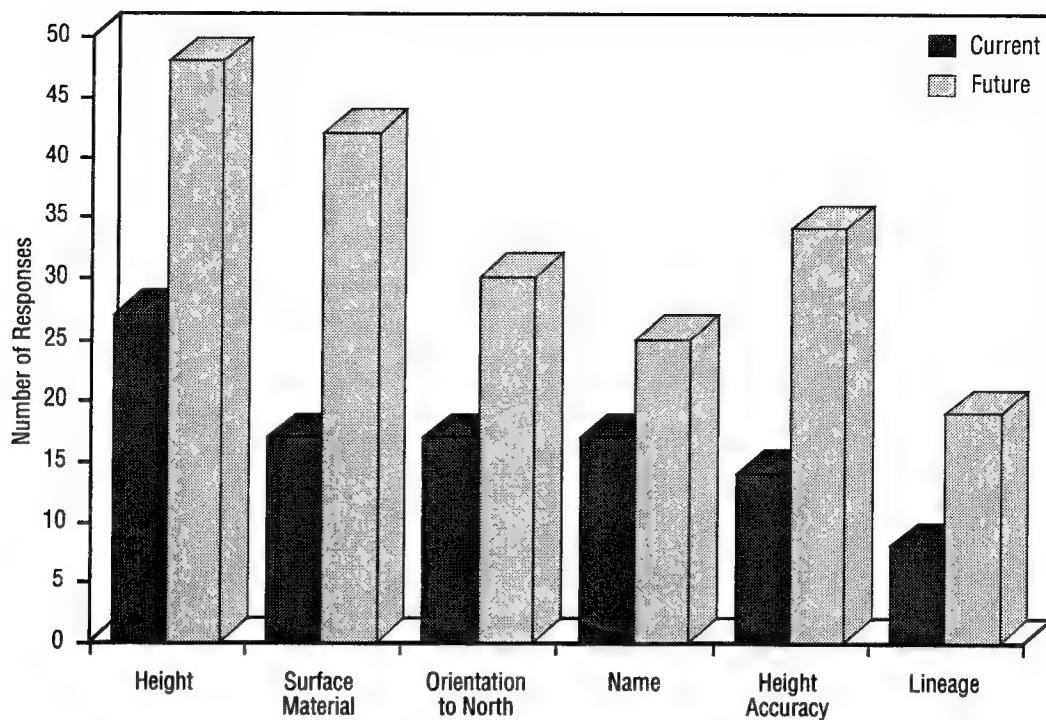


Fig. 32 — Current and future physiography attribute requirements

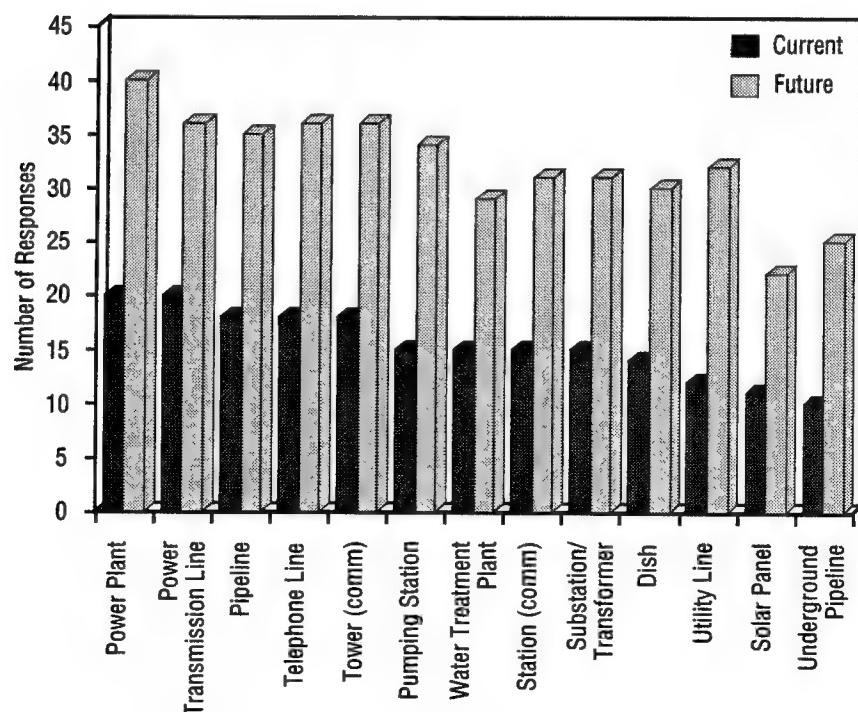


Fig. 33 — Current and future utility feature requirements

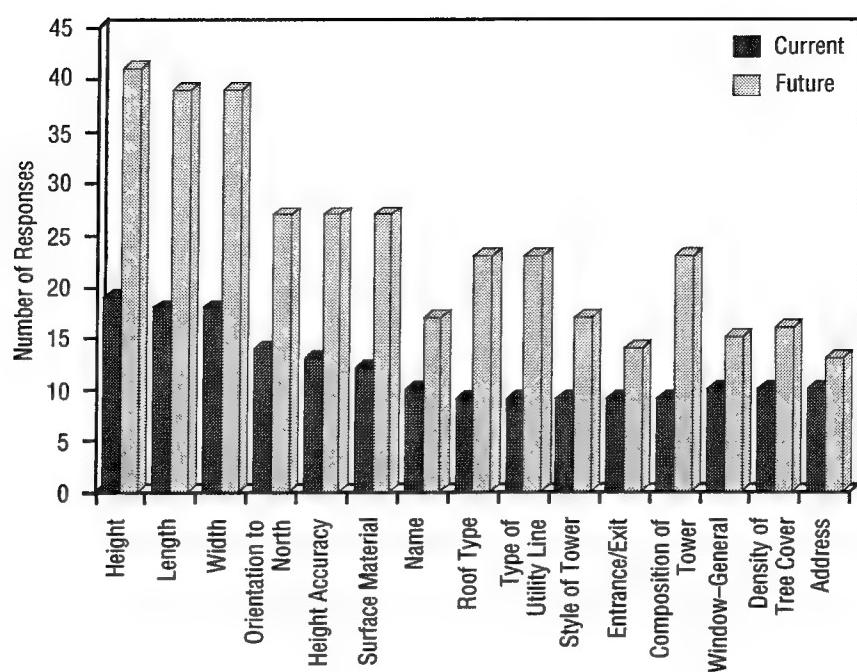


Fig. 34—Current and future utility attribute requirements

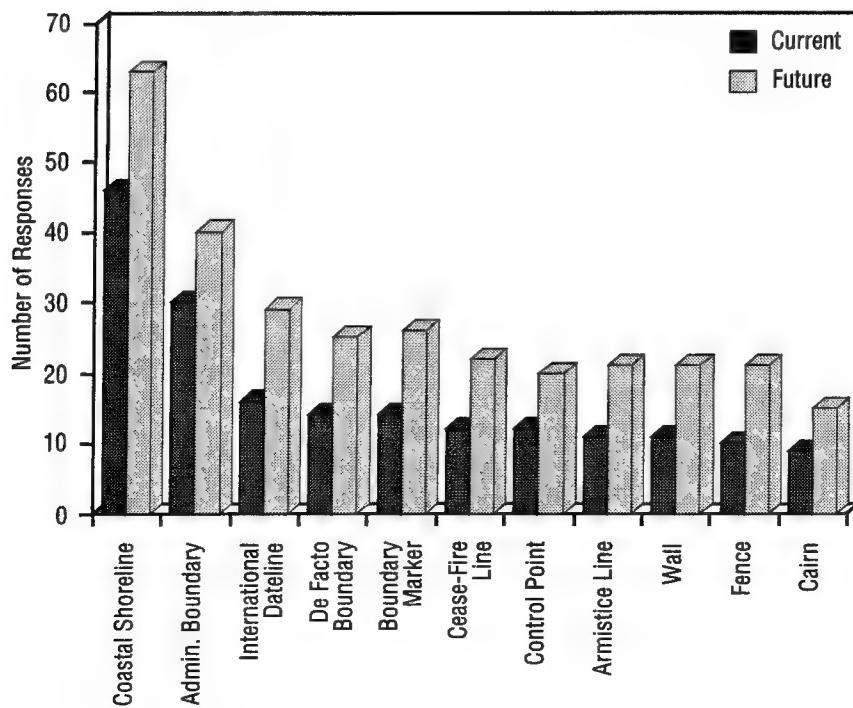


Fig. 35—Current and future boundary feature requirements

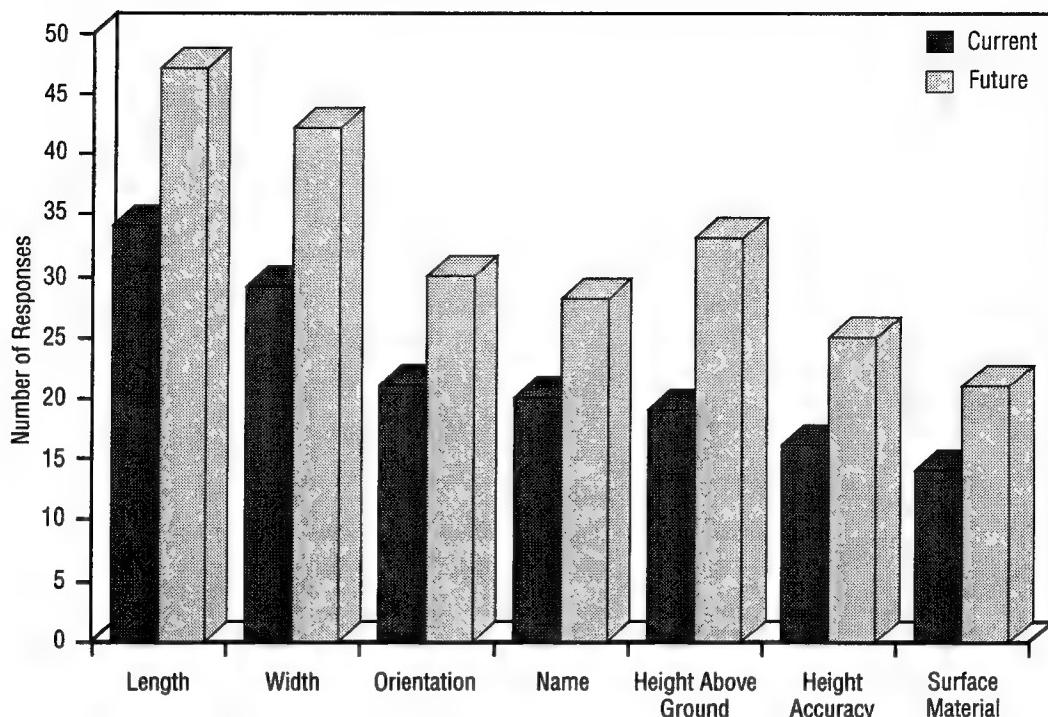


Fig. 36 — Current and future boundary attribute requirements

requires that specific feature (see Sec. 1.0). In almost all cases these additional requirements are both current and future. In those cases where the requirement is limited to current or future, it is noted as such. The table is structured so that each new feature is assigned a feature class.

The feature classes that contain these unmet requirements have associated absolute and relative accuracies and resolutions for horizontal and vertical measurements. The method of deciding the overall requirements for accuracies and resolutions was to use the mode, the most frequent occurrence, of the answers. In the case of ties, both modes are presented. For example, a mode listed as "25, 10" means that the same number of respondents had a 25-m requirement as had a 10-m requirement.

In almost all cases the future requirements were as stringent or more stringent than the current requirements. The fact that some requirements are less stringent in the future is probably due to the increased variability associated with future estimates of requirements. The horizontal requirements are presented in Table 12. The vertical requirements are presented in Table 13. The results are all in meters with current/future requirements presented in each table.

Each program surveyed was asked to identify the mission area where dMC&G data are being used. Many programs identified several mission areas with dMC&G requirements. The four mission areas with the largest number of users (86%) were research and development, analysis, rehearsal, and training. The feature classes required by each of these four mission areas are shown in Table 14. Table 14 shows both the current and future requirements of the four mission areas. As can be seen in every case, future requirements will significantly increase.

Table 15 shows the requirements of the individual users. This table demonstrates which users have extensive database needs and which have specific needs for specific products. The table

Table 9 — Most Required Current and Future Features from All Feature Classes

Key Features	Number of Responses		Feature Class
	Current	Future	
Depth Contour	35	47	Elevation
Land Contour	34	43	Elevation
Road	28	43	Transportation
Aircraft Facility	25	47	Transportation
Bridge	21	42	Transportation
Pier	0	42	Transportation
Trees	18	41	Vegetation
Marsh	17	36	Vegetation
Swamp	16	36	Vegetation
Shoreline	50	71	Hydrography
River	32	60	Hydrography
Open Water	31	50	Hydrography
Shipping Channel	0	50	Hydrography
Buildings	21	36	Populated Place
Built-up Areas	21	40	Populated Place
Fort	0	30	Populated Place
Processing Plant	15	29	Industry
Water Tower	14	29	Industry
Storage Tank	13	29	Industry
Cooling Tower	0	29	Industry
Chimney	0	31	Industry
Sand	25	45	Soil
Island	29	45	Physiography
Pack Ice	23	39	Physiography
Polar Ice	21	39	Physiography
Power Plant	20	40	Utility
Power Transmission Line	20	36	Utility
Telephone Line	0	36	Utility
Tower (communication)	0	36	Utility
Coastal Shoreline	46	63	Boundary
Admin. Boundary	30	40	Boundary

Table 10 — Commonality of Feature Classes

Commonality	Current Number of Occurrences	Future Number of Occurrences
All Feature Classes	4	15
All -1	6	4
All -2	1	7
Only One	Elevation 10 Hydrography 5 Populated Place 1 Boundary 3	Hydrography 4
Only Two	8	7
Elevation ... Boundary	35	57
Elevation ... Hydrography	34	59
Elevation ... Populated Place	33	44
Elevation ... Physiography	23	38
Elevation ... Transportation	22	43
Elevation ... Soil	21	36
Elevation ... Vegetation	20	48
Elevation ... Industry	17	33
Elevation ... Utility	16	34
Elevation ... Hydrography...Boundary	27	48
Elevation, Hydrography, Boundary	7	8
Elevation, Transportation, Vegetation, Populated Places, Industry, Utility, Boundary	1	2
Elevation, Vegetation, Hydrography, Soil	2	1
Elevation, Vegetation, Hydrography, Soil, Physiography, Boundary	1	2
Elevation, Hydrography, Physiography, Boundary	2	1
Elevation, Boundary	3	2

clearly indicates the wide range of needs and the fact that many users have a requirement for relatively few databases.

4.0 USE OF dMC&G DATA

This section discusses types of dMC&G products (both DMA and non-DMA) used by the Navy and the Marines, as well as the reported deficiencies and recommended improvements.

Tables 16 and 17 illustrate the wide variety of databases currently being used in the modeling and simulation community. Table 16 presents each database listed under each category, and Table 17 itemizes the most frequently used databases for each category (top three or four).

Table 16 reveals that the “other” category is the type of database most often utilized in the M&S community. This detail alone signifies the importance of such a study as this DMSO project. The responses demonstrated, on the whole, how unfamiliar the M&S community is with available dMC&G databases. Many of the users interviewed requested a list and description of databases

Table 11 — Additional Current and Future Requirements Not Presently Satisfied

ID Number	Requirement	Assigned or Designated Feature Class
063	Desert Information	Vegetation
066	Communication Nodes	Utility
053	Steam/Condensation Lines	Utility
054, 057, 061	Telephone Station	Utility
068	DFAD Features	Transportation
029	FLIP/DAFIF Features	Transportation
100	Fueling Areas	Transportation
093	Rocky Terrain	Soil
093	Plain Dirt	Soil
050	Beach (future only)	Soil
010	IR & NVG	Soil
011	Subways (future only)	Populated Place
102	Building Traits	Populated Place
063	Ridge Line	Physiography
107	Shallow-Water Features: Ground Surface	Physiography
089	Shelf (future only)	Physiography
105	Lava Flows	Physiography
005	Seamount	Physiography
089	Pinnacles (future only)	Physiography
015	Beach Slope (current requirement only)	Physiography
109	Well (future requirement only)	Industry
100	Fueling Areas	Industry
100	Fishing Industry	Hydrography
005	Mine-Like Objects	Hydrography
020	DFAD Features	Hydrography
100, 101	Sea Growth	Hydrography
015	Surf	Hydrography
026	Acoustics	Hydrography
005	Fish Information	Hydrography
026, 020	Bottom Type	Hydrography
101	Submerged or Partially Submerged Structures	Hydrography
005	False Targets: Acoustics	Hydrography
026	Sound Speed Profiles	Hydrography
026	Shipping Distribution	Hydrography
026, 107	Water Information	Hydrography
107	Tides and Currents	Hydrography
067	Key Tracking	Boundary
056, 057, 066	Demilitarized Zones	Boundary
067	Software Boundary	Boundary
063, 009	Restricted Airspace	Boundary

**Table 12 — Current/Future Horizontal Requirements
(Mode)**

Feature Class	Absolute Accuracy (m)	Relative Accuracy (m)	Resolution (m)
Hydrography	5/10	1/10, 1	1/1
Physiography	1/1	25, 10/1	1/10, 1
Vegetation	1/10, 1	5/10	1/10
Industry	1/10, 1	10/10, 1	1/1, 10
Soil	1/1	2.5/1	1/1
Populated Place	1/10, 1	25, 10/1	1/1
Boundary	5/5	10, 5/10, 5	1/1

**Table 13 — Current/Future Vertical Requirements
(Mode)**

Feature Class	Absolute Accuracy (m)	Relative Accuracy (m)	Resolution (m)
Hydrography	10, 1/5	1/10	3/3
Physiography	10/10	10/10	3/3
Vegetation	10/10, 1	1/10	3/3
Industry	10/5	25/10, 0.25	3/3
Soil	10/1	1/10, 0.25	3/3
Populated Place	5/5	25, 5/10, 5	3/3
Boundary	5/5	1/5	3,6,10,50/3

Table 14 — Current/Future Feature Class Requirements by Mission Area

Feature Class	R&D	Analysis	Rehearsal	Training
Elevation	37/44	23/28	6/8	16/26
Transportation	15/27	9/19	3/6	11/29
Vegetation	14/27	8/20	3/7	9/22
Hydrography	31/45	15/26	5/8	14/26
Populated Place	13/25	8/16	3/6	10/17
Industry	11/21	6/14	3/6	7/14
Soil	16/25	8/19	2/6	7/17
Utility	12/22	6/14	3/6	6/14
Physiography	14/22	10/16	4/5	10/14
Boundary	26/37	14/22	5/7	17/24
Other	18/21	1/1	1/1	4/4

Table 15—Current (c) and Future (f) Requirements of Each Respondent in the Survey

Table 15 — Continued

ID Number	Notes	Elevation	Transportation	Vegetation	Hydrography	Populated Place	Industry	Soil	Utility	Physiography	Boundary	Other (list)
032				f								cf f points of interest f bottom topography
033					f							cf cf cf
034		f										
035		cf			cf							
036		cf			cf							
037		cf			cf							
038		cf			cf							
039		f			f							
040	f -2	f	cf	f	f	f	f	f	f	cf	cf	cf f
041		f	cf	f	f	f	f	f	f	cf	cf	cf f
042		cf	cf	cf	cf	cf	cf	cf	cf	cf	cf	cf coastline
043		f	cf	cf	cf	cf	cf	cf	cf	cf	cf	cf cf
044		cf	cf	cf	cf	cf	cf	cf	cf	cf	cf	cf cf sensitivity areas
045		cf	cf	cf	cf	cf	cf	cf	cf	cf	cf	cf cf
046		f	cf	cf	cf	cf	cf	cf	cf	cf	cf	cf cf
047		cf	cf	cf	cf	cf	cf	cf	cf	cf	cf	cf cf
048												
049		f										
050		cf										
051		cf										
052	cf -1 cf all	cf	cf	cf	cf	cf	cf	cf	cf	cf	cf	cf cf airfield
053	cf all	cf	cf	cf	cf	cf	cf	cf	cf	cf	cf	cf f
054		cf										
055												
056		cf										
057		cf										
058	c -1 f all	cf	cf	cf	cf	cf	cf	cf	cf	cf	cf	cf f
059		cf										
060		f			f	f	f	f	f	f	f	f
061	f all	cf			f	f	f	f	f	f	f	f
062	f all	cf			f	f	f	f	f	f	f	f
063		cf			f	f	f	f	f	f	f	f
064	f -2	cf			cf	cf	cf	cf	cf	cf	cf	f
065					f							

Table 15—Continued

ID Number	Notes	Elevation	Transportation	Vegetation	Hydrography	Populated Place	Industry	Soil	Utility	Physiography	Boundary	Other (list)
066	cf all	cf	cf	cf	cf			cf	cf	cf	cf	cf IR emissivity cf radar reflectivity cf electrostatic reflectivity
067	f all	cf	cf	cf	cf			cf	cf	cf	cf	
068		cf	cf	f	f			cf	cf	cf	cf	
069												
070												
071												
072												
073	f	cf	cf	f	f			cf	cf	cf	cf	
074												
075												
076	f -1	cf	cf	cf	cf			cf	cf	cf	cf	
077												
078												
079												
080	f -2	f	f	f	f			f	f	f	cf	
081												
082												
083												
084												
085	f all	cf	cf	cf	cf			cf	cf	cf	cf	
086												
087												
088	cf -1	cf	cf	cf	cf			cf	cf	cf	cf	
089												
090	f all	cf	cf	cf	cf			cf	cf	cf	cf	
091												
092	c -1	cf	cf	cf	cf			cf	cf	cf	cf	
093	f all	cf	cf	cf	cf			cf	cf	cf	cf	
094												
095	f -2	cf	cf	f	f			cf	cf	cf	cf	
096	f -2	cf	cf	f	f			f	f	f	f	
097	f all	f	f	f	f			f	f	f	f	

Table 15—Continued

ID Number	Notes	Elevation	Transportation	Vegetation	Hydrography	Populated Place	Industry	Soil	Utility	Physiography	Boundary	Other (list)
098		f	f	f	f	f	f	f	f	f	f	f hospitals
099		f	f	f	cf	f	f	f	f	f	f	
100		cf		cf						cf	cf	
101		cf	cf	cf	cf					cf	cf	
102	f -2	cf	cf	cf	cf	cf	cf	cf	cf	cf	cf	cf building traits
103		cf	f	f	f	f	f	f	f	f	f	
104	f all	f	f	f	cf	cf	cf	cf	cf	cf	cf	
105		cf	cf	cf	cf							
106		cf	cf	cf	cf	cf	cf	cf	cf	cf	cf	
107	cf depth						cf underwater		cf underwater			
108	cf all	cf	cf	cf	cf	cf	cf	cf	cf	cf	cf	cf watermasses cf currents
109	f all	cf	f	f	f	f	f	f	f	f	f	
110												
Current		58	26	23	47	26	17	23	17	28	42	
Future		74	45	50	70	46	34	42	36	42	60	

Table 16 — Specific Data Sources Used

Type	No.	Data Sources
Oceanography	43	DBDB, NOAA, NGDC, MOODS, GDEM, WVS, OAML, NAVOCEANO, TESS, NOSL, SST, DMA, DNC, Levitus, MSDDDB, FNMOC, NSC/AWOIS, In-house
Terrain	47	DTED, DBDB, WVS, OAML, DFAD, USGS, NGDC, FNMOC, JOTS, NAVOCEANO, Navy, DMA, In-house
Magnetics/Gravity	17	NOAA, NGDC, OAML, NAVOCEANO, MSDDDB, MADDB, GFMPL, USGS, In-house
Space/Exosphere	6	NOAA, NAVOCEANO, OAML
Atmosphere	20	NOAA, OAML, NAVOCEANO, TESS, NORAPS, NOGAPS, FNMOC, APL, HEPL, HEP CDB, In-house
Weather	34	OAML, NOAA, NGDC, TESS, FNMOC, HWS, NAVOCEANO, NCDC, NWS, GUAL, PICS/NODDS, CNMOC, ECWF, In-house
Sensors	31	OAML, NAVOCEANO, NOAA, NGDC, NERF, EWIR, NAVAIR, FASTC, FSTC, NRL, NASA, NAWC, EWOP, FAC, MSIC, PINS, NID, Navy, In-house
Emitters	23	EPL, EWIR, ELINT, OAML, NAVOCEANO, MSIC, NERF, NID, ENWS, EWOP, FAC, AFEWC, EMI, FASTC, FSTC, In-house
Manpower/Personnel	4	NAVOCEANO, Navy, In-house
Finance/Budget	4	NAVOCEANO, Navy, In-house
Transportation	9	NAVOCEANO, NTDS, USGS, Navy, PTG, FLJP, Census, In-house
Weapons	32	MIID-IDB, EWIR, OAML, NAVOCEANO, NID, NTDS, MSIC, FASTC, FSTC, NWTDB, NERF, NAVAIR, PTC, TACMAN, IMEMS, SYSCOMS, EWOP, Navy, In-house
Radars	28	EWIR, NERF, MIID-IDB, OAML, NAVOCEANO, ENWS, NID, FASTC, FSTC, AFEWC, NWTDB, EPL, MSIC, APL, Navy, NAVAIR, In-house
Communications	18	OAML, NAVOCEANO, NID, EWIR, NERF, MIID-IDB, NATOPS, ASWTD, MSIC, FASTC, EWOP, FAC, Navy, In-house
Population	5	Census, NAVOCEANO, Navy, In-house
Imagery	28	MSI, EROS, LANDSAT, SPOT, MSS/TM, NOAA, NGDC, NAVOCEANO, MATRIX, EO, CAD2, COMSUB, FNMOC, In-house
2-D Graphics	29	NAVOCEANO, NGDC, DTED, CAC, AQUARIUS, ARC/INFO, TSI, NRL, USGS, NAVFAC, In-house
3-D Graphics	32	DTED, NAVOCEANO, NGDC, SIMNET, COSMIC, AQUARIUS, PHIGS, USGS, ARC/INFO, MULTIGEN, GEMINI, TSI, NRL, NAVFAC, In-house
Other	52	DBDBS, DAFIF, WVS, CIA, IHO, CADB, ERSS, DMSP/SSMI, MOODS, GDEM, Levitus, DCW, WDBII, GEM, FNMOC, ERS, GFO, TOPEX, ICAPS, IR, PINS, OAML, SPOT, AVHRR, AFEWC, DAFIF, DMSP, SPOT, NAVAIR, In-house

Table 17 — Data Sources Most Frequently Used for Each Type of Modeling/Simulation Activity

Type	Data Source	Frequency
Oceanography	OAML DBDB NAVOCEANO NGDC, NOAA	11 5 4 3 ea
Terrain	DTED USGS DMA OAML, NAVOCEANO, WVS, In-house	21 4 3 2 ea
Magnetics/Gravity	NAVOCEANO OAML NOAA NGDC	5 3 3 2
Space/Exosphere	NOAA OAML, NAVOCEANO	2 1 ea
Atmosphere	NOAA NAVOCEANO, OAML TESS	4 3 ea 2
Weather	FNMOC, NOAA OAML, TESS	6 ea 4 ea
Sensors	In-house OAML NAVOCEANO, NERF	9 3 2 ea
Emitters	In-house, EWIR EPL, ELINT, NERF, NAVOCEANO	3 ea 2 ea
Manpower/Personnel	In-house NAVOCEANO, Navy	2 1 ea
Finance/Budget	In-house NAVOCEANO, Navy	2 1 ea
Transportation	In-house, Census, NAVOCEANO	2 ea
Weapons	In-house MIID-IDB, EWIR, NWTDB, NAVOCEANO	9 2 ea
Radars	In-house EWIR NAVOCEANO	5 4 2
Communications	EWIR, NAVOCEANO, Navy OAML, NID, NERF, NATOPS, ASWTDA, FASTC, FAC, MSIC, Navy, EWOP, MIID-IDB	2 1 ea
Population	In-house, Census NAVOCEANO, Navy	2 ea 1 ea
Imagery	In-house SPOT, LANDSAT MSI, NAVOCEANO, NGDC	4 3 ea 2 ea
2-D Graphics	In-house DTED	13 2
3-D Graphics	In-house DTED	7 4
Other	In-house WVS, DBDB SPOT, GDEM, DAFIF	21 3 2

available from DMA (*Digitizing the Future*¹ was referred to the users). In addition, many were interested in a similar list from NAVOCEANO. This interest indicates the need for a listing or a source of available databases. The OAML would provide a good starting point for the listing of NAVOCEANO products.

Table 16 also lists the names of the sources in use. Although a wide range of databases is being utilized, one glance at this table illustrates the confusion shared by many as to the source and/or name of the database in use. It must be emphasized at this time that these observations are not intended in any way to slight or fault the M&S community. Education and standardization in the availability of dMC&G products would facilitate optimum utilization of these data.

Table 17 lists the most frequently used database for each category. This table demonstrates the importance of existing databases for specific types of M&S and at the same time illustrates certain deficiencies. For instance, 12 of the 19 categories utilize "In-house" databases more (or as frequently) than any existing database. This situation clearly illustrates the need to identify and fulfill the requirements of this community.

4.1 dMC&G Sources: Current and Future Use

Of the 110 responses submitted, 79 programs reported the use of dMC&G data. These data were grouped into the following types: DMA and non-DMA (other government agency, produced by contractors, or internally produced). Users were asked the quantity (approximate percentage) of data used in their work and their anticipated employment of that particular data. Figs. 37 and 38 give a summary of the responses, with percentages grouped into ranges of 25. (Note on interval notation: [a,b) includes a, excludes b.)

As reported, DMA products are currently used by 56 programs, many of which have working data sets comprised of at least 75% DMA product. In particular, of the 39 programs that fall in the range [75,100] of DMA percentage use, 22 are currently using DMA products exclusively. Future use of DMA data is expected by 9 additional programs, with an increase of 5 in the [75,100] range. The future number of those programs using 100% DMA data remains approximately the same (24).

The number of products obtained from non-DMA sources figures prominently in the survey: 47 projects use non-DMA products. Thirty-three projects use data produced by "other government agencies," the majority relies on data from NAVOCEANO, the U.S. Geological Survey, the CIA, CNMOC, and the Federal Aviation Agency. Some additional sources mentioned are the U.S. Army Topographic Engineering Center (TEC), the NGDC, and TIGER data available from the U.S. Census Bureau. Three of the 33 projects plan to discontinue use of these "other government" products and will either begin or increase their use of DMA data.

In the area of "contractor supplied data," a similar situation occurs: 2 of the 12 who currently use contractors report the discontinuance of the contractor-supplied data and an increased use in DMA-supplied data. Only 1 of the 12 programs that reported future use of "contractor data," while not using contractor data currently, is a DMA product user.

¹ *Digitizing the Future*, Third Edition, DMA Stock No. DDIPDITALPAC.

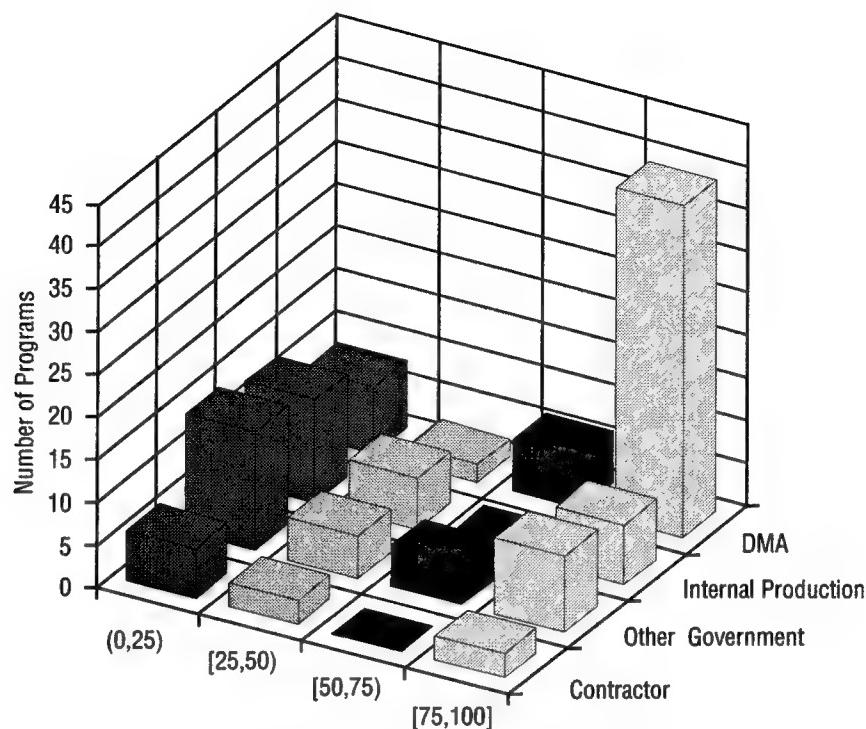


Fig. 37 — Current use of dMC&G data from each source

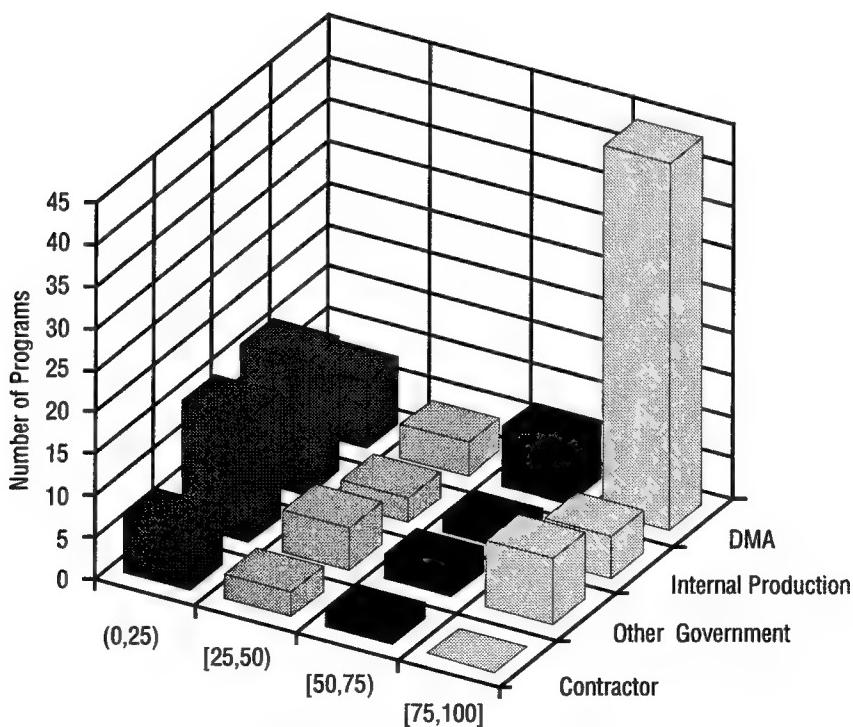


Fig. 38 — Future use of dMC&G data from each source

"Internally produced data" users presently number 26, and 3 users plan to decrease such use. Two of the three plan to use DMA products to some extent in the future. Of the three that plan to produce internal data for use in the future, two report a future decrease in use of DMA products.

4.2 dMC&G Products: Current and Future Use

The products used for dMC&G purposes are grouped into DMA and non-DMA. For the most part, respondents selected from a list of options provided in the questionnaire. "Other" responses, particularly those relating to non-DMA data, are also included.

Figure 39 lists non-DMA products and the number of programs using or planning to use one or more of these products. An interesting conclusion to be made from Fig. 39 is that SPOT, LANDSAT, and AVHRR (i.e., imagery products) show the greatest potential for increased use.

Mentioned in the "other" category were a variety of products, with no particular product leading in popularity. TM data (LANDSAT) are presently being used for dMC&G purposes by two programs. Other sources included were HRB, ERSI, GEOSAT, SEAWifs, and CZCS.

Figure 40 presents DMA product names and the total number of programs that either use or will use one or more of these products. The products are listed in order of increasing use.

As shown in Fig. 40, DTED L1, WVS, and DBDB5 are the primary products being used at present. All show an expected increased use in the future, with the greatest increase being in DTED L2, DFAD L1, DBDB 0.5, and DCW. In the "other" category, two entries were submitted in the survey: NSC and ETOPO5.

4.3 Project and System Information

4.3.1 User Processing Attributes

In regard to the preprocessing of DMA products, 62 programs that incorporate dMC&G responded. Of the 62, 47 require some preprocessing of DMA data before using them. The most common task is reformatting (via compression or other transformations) to produce more "suitable" data for the user's environment. Additional preprocessing tasks that are used involve interpolating, thinning, resampling, removing headers, and condensing to binary format. Some of the affirmative responses explained the preprocessing and the specific data being processed. Of all DMA products, CAC and DTED are preprocessed in 4 of the 47 projects that noted preprocessing. An example action taken is the conversion of CAC into a particular database format or planning system. With DTED, compression, edge matching, and basic reformatting are required to produce enhanced processing or an efficient environment in which to use the data (space considerations, etc.). Some additional explicitly stated products that require some form of preprocessing are DBDB5, ADRG, WVS, PPDB, and DAFIF.

Justifications for preprocessing are as varied as the types of preprocessing. One reason is access. The formats provided by DMA, according to at least 3 of the 47, lead to slow data access; hence, the need for reformatting exists. Unfortunately, in some of the conversions to database format, accuracies are corrupted (e.g., DAFIF, DTED, and CAC are three such products being reformatted into dbVista).

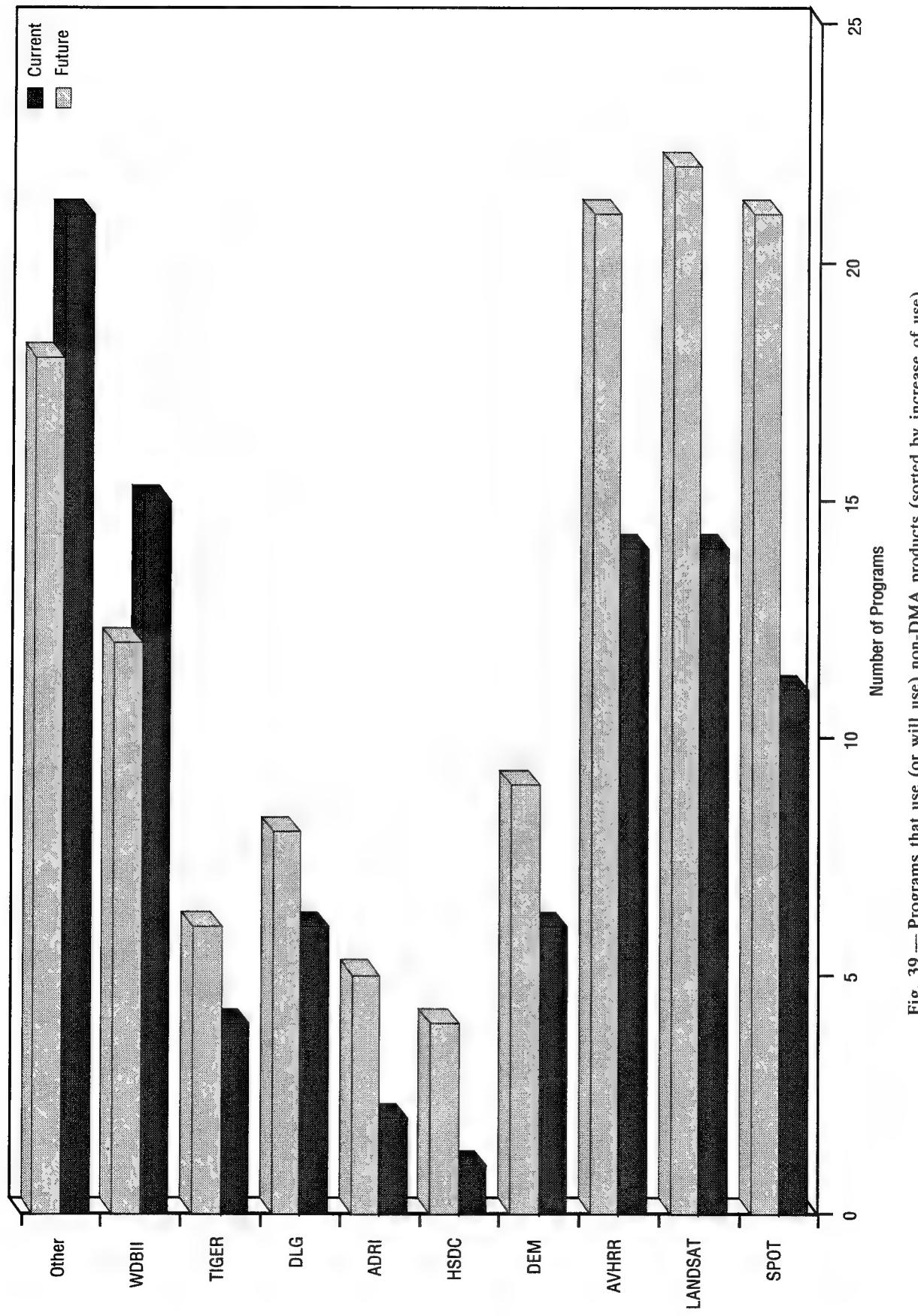


Fig. 39—Programs that use (or will use) non-DMA products (sorted by increase of use)

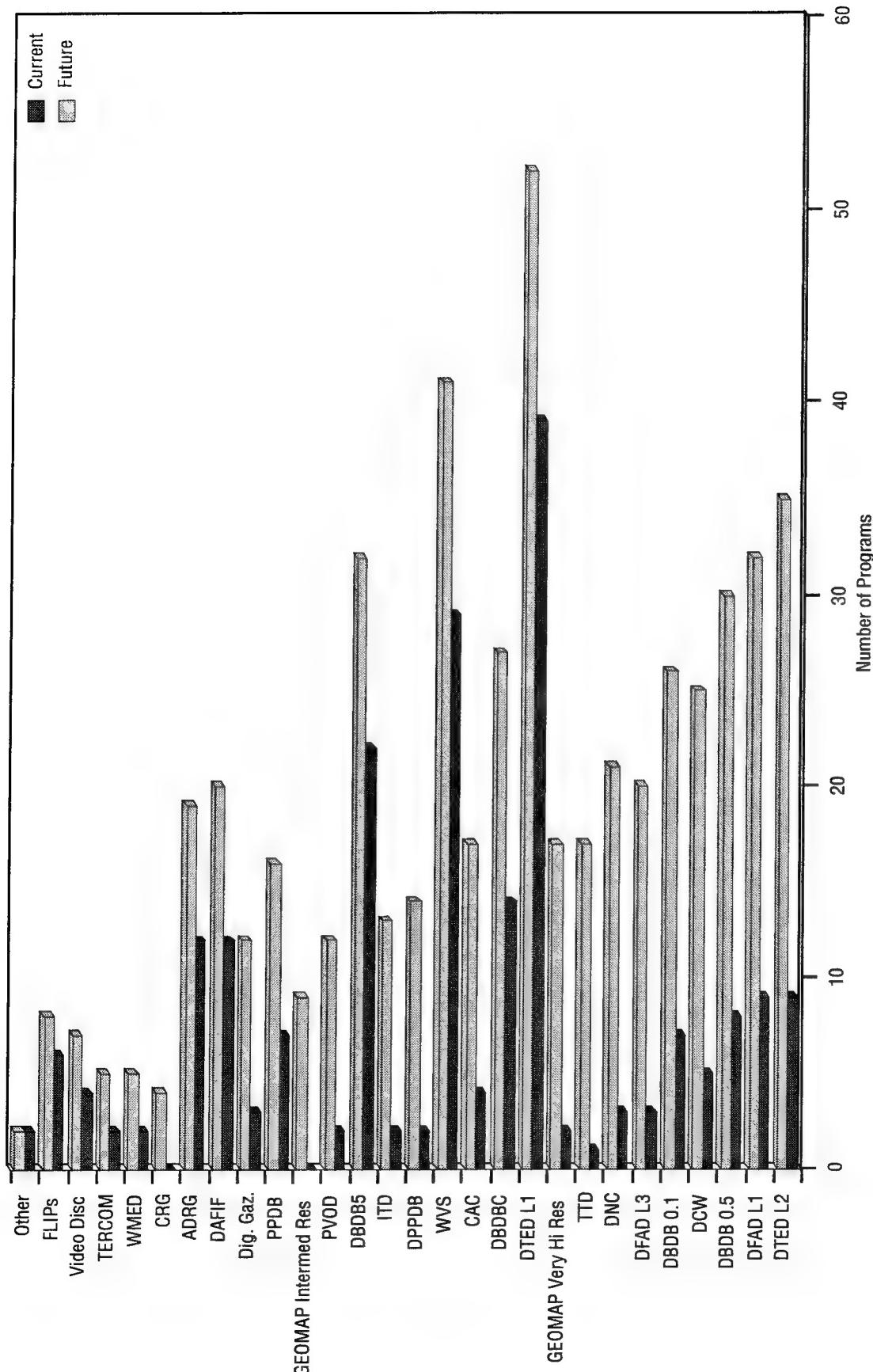


Fig. 40 — Programs that use (or will use) DMA products (sorted by increase of use)

Figure 41 summarizes the number of programs directly using DMA products and the various types of preprocessing used. Note: a single project may use several preprocessing techniques.

Importing standard DMA products is another topic of consideration in those projects that use digital mapping data. Currently, 41 programs have access to systems that are capable of directly importing standard DMA products. An additional 18 will have such capability in the future. Only nine respondents have no such capability.

4.3.2 DMA and DoD Procedures Governing dMC&G Data

As noted earlier in this section, many programs incorporate the use of non-DMA products. In fact, the use of these products in the dMC&G area is, for the most part, increasing.

Standard DMA products can be obtained only through certain channels. When asked if procedures were known for obtaining standard DMA products and product descriptions, 48 of 74 programs responded affirmatively. Only 28 of the 74 are familiar with the method for requesting development of new or nonstandard products from DMA. Navy users do not, in general, know that all imagery should be obtained through DMA.

Likewise, many of the DoD policies and capabilities are unfamiliar to the users of dMC&G data. For instance, only 13 of 70 programs were acquainted with the recent DoD policy governing the transformation of dMC&G data. Figure 42 gives the number of projects with knowledge of DoD transformation capabilities and development efforts. The "other" category includes two entries, GEMPLEX and CRG.

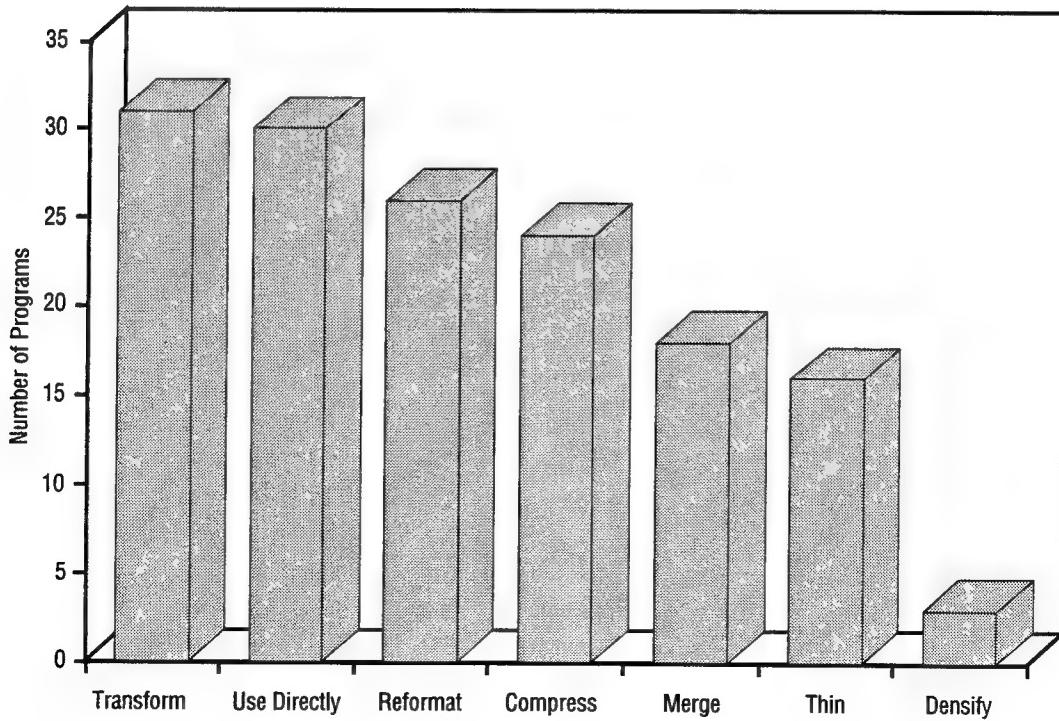


Fig. 41 — Programs applying preprocessing techniques to DMA products

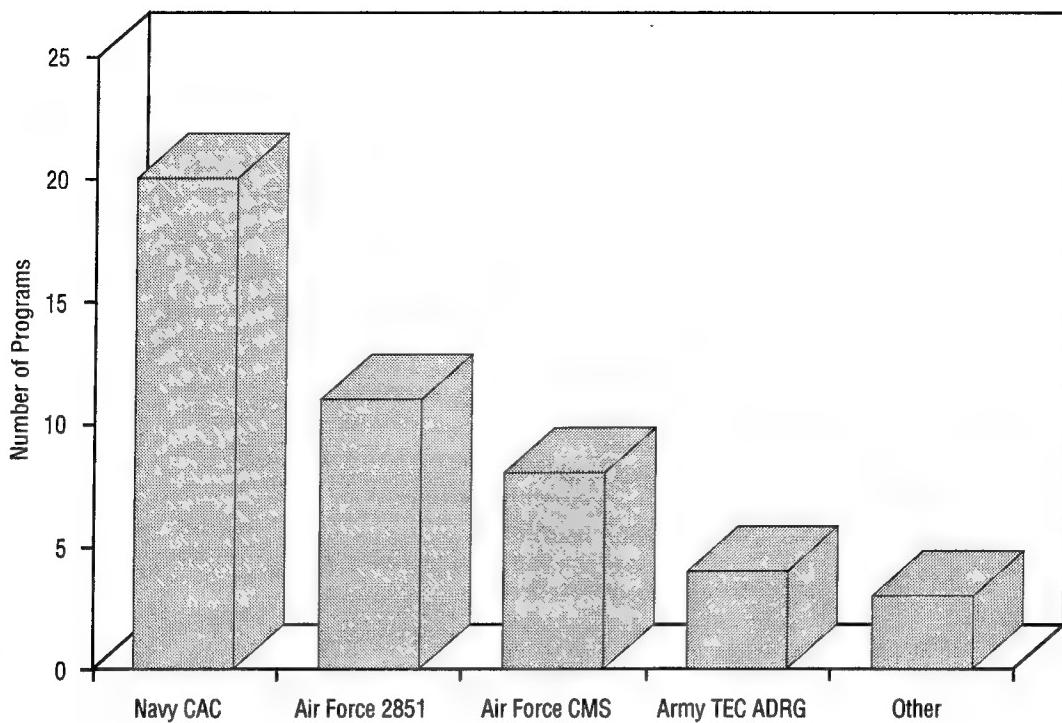


Fig. 42 — Programs aware of specific DoD transformation capabilities and development efforts

4.3.3 Proprietary Data

With respect to proprietary or system-specific data, the majority (47 of 79) do not use and have no plan to use such data. Twenty-one programs currently use proprietary dMC&G data, and only an additional four anticipate doing so in the future.

4.3.4 Products from Contractors and Other Government Agencies

Of the responding projects using dMC&G, 10 gave specifics on the type of contractor-supplied data and related information. With the exception of a few general responses, those respondents who use contractor-supplied data are summarized in Table 18.

Eight projects use products taken from agencies other than DMA. Table 19 points out attributes of these products.

As with contractor-supplied data, a few programs reported the general use of other agency-supplied data, but gave no specific details as to their use (as shown by blank space in the tables). All but two of the programs that paid contractors or other government agencies for a dMC&G product did not initially submit a data requirement to DMA.

4.4 Value-Added Data

By the information provided in the tables, which state requirements not met by the products VMap, UVMap, ITD, and DNC (see Sec. 2.0), it is apparent that some features are not typically

Table 18 — Contractor-Supplied Products and Related Information

Contractor-Supplied Product	Geographic Area	Resolution	Cost
GEM-SIGRID	45° N	15-ft grid	
WVS-GEM	Global	Multiscale	
SEA-D	U.S.	NOAA Chart	\$600
Surf Database	Littoral Zone	0.1 nmi	\$50K
SPOT			
DeLorme (used by 2 programs)	Global		\$150K
DPPDB	China Lake, CA		\$40K
Drawings	Quantico, VA		
TSI DB			

Table 19 — Other Government Agency Products and Related Information

Agency-Supplied Product	Geographic Area	Resolution	Cost
OAML (by NAVOCEANO)	Global		
WVS-Compressed (used by 2 programs)	Global	Multiscale	
AUTOCAD	Neah Bay, WA		\$600
Route Survey	CONUS	450+ m	
TEC-Army Topo Engineering			
SIMNET DB			

included in DMA products. These features could be referred to as value-added data. Additional examples can be found in Sec. 3.0.

Responses to the questions relating to value-added data were few. In fact, this type of data is used in only 22 of the projects using dMC&G. Only 11 programs presented detailed uses of their value-added data. Some comments on how such data are used describe a lack of performance or overall insufficiency of DMA data. For example, a common task is to merge or add other data to DMA products to produce a “better” product or “add value” to the product.

More specifics on how value-added data are used in conjunction with DMA data are listed in Table 20. All responses are listed together with the project ID number.

4.5 DMA Product Deficiencies

From all programs that responded to the use of dMC&G data, 43 are dissatisfied with at least one DMA product. Figure 43 displays a frequency histogram with cited deficiencies divided into six categories (content, resolution, etc.). As shown, content, resolution, and accuracy are the specific areas where DMA products seem to be the most deficient.

Figure 44 displays the products that were frequently mentioned as being insufficient for a particular dMC&G process.

Table 20 — Value-Added Data and Associated Information

ID	Value-Added Data	Source	Description of Use with DMA Data	Standards
028	ECMOP	INO	Used where DMA data is insufficient	NWTDB, DIS Protocol
030	In Situ Synthetic Exercise/Sea-Test Results	Sensor Inputs R&D Inputs N/A	Merge routines for additional georeferenced thematic layers, correction to historical values with real-time inputs, nested high-resolution data sets	JOTS
035	Thinning, Island Removal		Used to speed up displaying data and saves space	
042	Environmental Observation Communication Network		Not overlaid with MC&G database	WMO, IHO, GENTACs, and USMTF
043	Oceanic Data Ocean Environment Ocean Acoustics	Multiple Sources	Oil company data and Navy-surveyed data will be put together, making a common grid of all oceans and atmospheric data to 0.1° resolution	
049	Environmental	Land and Sea Platforms	Merge DMA data with other data for better product	
050	Wind Data, Acoustic, Wave Data, Sea Surface Height	FNMOC	Used on top of DBDB5 or DBDB1 and uses WVS to mask coastlines	
062	Shaded Relief Movable Objects	In-house	With DTED, generate shaded relief map, grids, movable objects	
064	Texture Mapping	In-house	Placed atop DMA data	
068	Add Icons, Merge TIDES, Add Trap TRE, Materials Reflectivity, Spectral Translation	Target Models	Use DMA data as background (adding it because it is not there yet)	

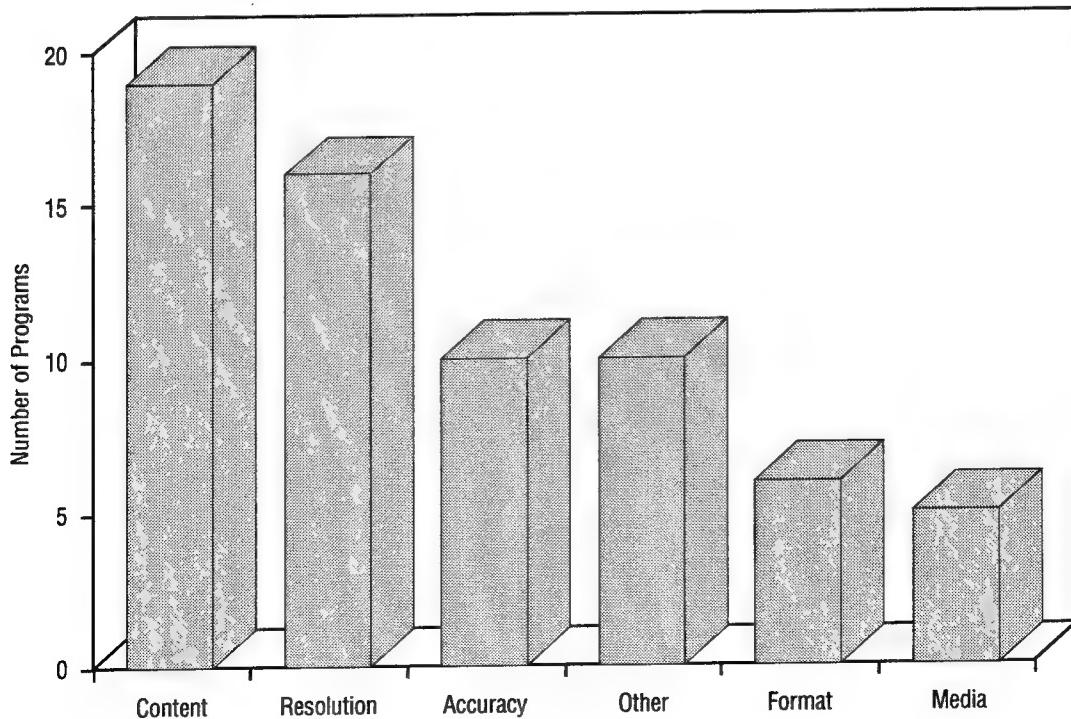


Fig. 43 — Programs indicating deficiencies of DMA products

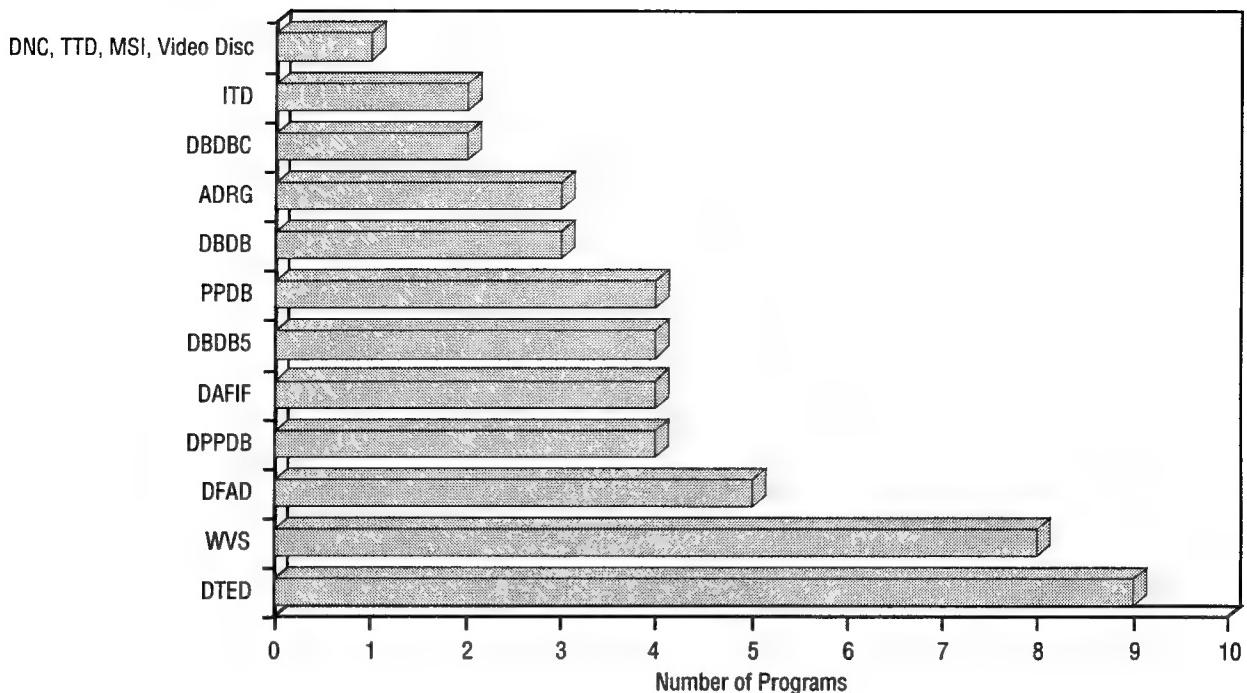


Fig. 44 — Programs indicating deficiency or requirement/improvement

As can be seen from Fig. 44, DTED and WVS are the most frequently mentioned as not meeting requirements. General inaccuracies account for the majority of complaints with DTED. Noisiness and unmatched edges are additional complaints, as well as the fact that not all DTED data are available on CD-ROM. With WVS, the problems stem from scale, overlap, missing topology, nearshore zone deficiencies, and a "too coarse" resolution. DFAD falls short in the area of features available (e.g., three-dimensional mapping) and accuracies. DAFIF, DBDB5, PPDB, and DPPDB were equal in the next largest number of complaints. Complaints on DPPDB are in the area of accuracy, resolution, and media (e.g., program desired DPPDB on 8 mm and CD-ROM).

Categories in which a particular DMA product is lacking, according to the 43 responding programs, are given in Table 21. The entire listing of deficiencies and associated program IDs are given in Tables 23 through 28.

Attention is now turned to those programs using non-DMA data and reasons why DMA products are not employed. Thirty-four programs gave three primary reasons why DMA products are not used: availability, content, and access. Specifically, one-half of the 34 were unaware of available DMA products. Twelve projects believed that the feature content of some DMA products was insufficient. Another reason for non-DMA product use, for 10 projects, was that it simply took too long to acquire DMA data. Table 22 shows the entire set of reasons together with the corresponding frequency.

Certain features in this table should be emphasized. Of particular importance are those responses in the "not aware of" category. Four programs report a lack of knowledge with respect to imagery products, with comments ranging from "no imagery available" to "not aware of imagery product." It is obvious from the data that the mechanics of obtaining DMA digital products are too complex and too slow.

Table 21 — Categories in which DMA Products are Lacking

DMA Product	Category of Deficiency
DTED	Content, accuracy, resolution, media
WVS	Content, accuracy, resolution, format
DFAD	Content, accuracy, media
DPPDB	Accuracy, resolution, media
DAFIF	Content, accuracy, format
PPDB	Content, accuracy, resolution
DBDBC	Content, resolution
ITD	Resolution, media
DBDB5	Content
DBDB	Resolution
ADRG	Format
DNC	Resolution
TTD	Resolution
MSI	Media
Video Disc	Media

Table 22 — Number of Programs and Reasons for Using Non-DMA Products

Number of Programs	Reason
17	Not aware of available DMA products
12	DMA product feature content is insufficient
10	Too long to acquire required DMA data
7	Resolution of DMA products is insufficient
6	System cannot import DMA products
6	Accuracy of DMA products is insufficient
6	DMA products do not cover required areas
6	Other*
5	DMA data requires too much preprocessing
4	System cannot process DMA data efficiently
3	DMA products are not packaged as required
3	Did not submit product requirement (assumed DMA would not validate it)
2	DMA products contain too much data
1	The digital map database was a contract deliverable

* The "other" category included four responses indicating product unavailability from DMA, one indicating development by researcher, and one indicating that the program was nongovernment.

Table 23 — Programs Indicating Content Deficiencies in DMA Products

ID Number	DMA Product	Deficiency/Requirement
001	DAFIF	No WACs over ocean areas
005	Not Identified	Mine-like objects, develop database
006	DBDB5	Poor shallow-water accuracy
010	DFAD	Should include NVG, IR features, and tactical parameters
022	High Res. PPDB	Currentness
032	Not Identified	High frequency/weapons frequency insufficient data collected
042	WVS	Needs single shoreline
045	DBDB5	Lack of available data leads to lack of accuracy
047	DBDB5	Not based on any water shallower than 200 m; need shallow-water data
049	WVS, DBDBC	Nearshore zone deficient
058	DTED	Inaccuracies
060	WVS	Overlap
066	DTED L1	Consistency of source materials; need more accuracy, 10 m and better relative vertical accuracy
076	DFAD	Needs to be three-dimensionally mapped
095	DAFIF	Not compatible
100	WVS	Topology missing
107	Not Identified	Bottom composition doesn't exist; create database containing bottom composition as a function of area
109	Not Identified	Spotty coverage, more coverage of the world

Table 24 — Programs Indicating Accuracy Deficiencies in DMA Products

ID Number	DMA Product	Deficiency/Requirement
006	Not Identified	5–10% improvement needed
008	WVS	Bathymetry, thermography, and locations don't match (don't correspond to shoreline)
010	DFAD	Cell-to-cell accuracy
022	MK85 PPDP	Inaccurate locations, need GPS locations
037	Nonsubmarine Contacts	Label source, lineage
062	DTED	Need equivalent to GPS
068	PPDB/DPPDB	Inaccuracy
093	DFAD	Data, distribution and accuracy; corrections of data in all products (i.e., same)
095	DAFIF	Noisy and not matched at edges
108	DTED	

Table 25 — Programs Indicating Resolution Deficiencies in DMA Products

ID Number	DMA Product	Deficiency/Requirement
006	Not Identified	2 or 1 minute
011	DTED	Need 1-m posting
018	Not Identified	Need higher resolution
028	WVS	Too coarse, increase resolution
030	DBDB	Need greater resolution
041	DBDBC, DBDB	Need Bermuda, High Resolution
049	Not Identified	Need beach data to 0.1-nmi resolution
052	Not Identified	Need larger scale
053	Not Identified	Need larger scale
068	PPDB/DPPDB	Equivalent to GPS
073	DNC	Increase data resolution
100	WVS	Scale
105	TTD, ITD	1:50,000, need 1:24,000
107	DBDB	Resolution and scale of bathymetry is too coarse
109	Not Identified	Vertical not adequate, include ridge lines

Table 26 — Programs Indicating Format Deficiencies in DMA Products

ID Number	DMA Product	Deficiency/Requirement
035	WVS	Nonstandard, need standard fast access
056	ADRG	24-bit color, need 8-bit standard
057	ADRG	24-bit color, need 8-bit standard (produce as a product or standard compression algorithm)
062	ADRG	24 bits too much, need 8 bits
090	Not Identified	24-bit scans, need color separates
096	DAFIF	Record format, adherence to format

Table 27 — Programs Indicating Media Deficiencies in DMA Products

ID Number	DMA Product	Deficiency/Requirement
022	All High Volume	Slow, need high-speed, high-density distribution alternative
049	Not Identified	Digital
068	DPPDB	Need 8 mm and CD-ROM
105	MSI, MC&G Video Disc, ITD	Need CD-ROM
108	DFAD, DTED	Need CD-ROM

4.6 Recommendations for Improvement

Practically all recommendations for improving DMA products were in general terms, e.g., “increase the accuracy” or “need higher resolution.” Some insight can be gained, however, by considering the deficiencies that were reported for specific products, as well as any suggested improvement by a program. For example, one suggested improvement to ADRG was given by three projects: change from 24-bit color to 8-bit standard.

Table 28 — Programs Indicating Other Deficiencies in DMA Products

ID Number	DMA Product	Deficiency/Requirement
007	DTED	Extraneous data points
009	DTED	Areas in California—holes in the data set
010	Not Identified	Models of tanks, aircrafts are not available
012	DTED	Inaccuracies, wrong in certain cells
026	DBDBS	Extrapolation for incomplete data is unacceptable
068	DPPDB	Currentness
092	Not Identified	In general, too small-scale; need large-scale 1:25,000 and larger
095	Not Identified	Need all data products in standard format
109	Not Identified	Not responsive, too long to get data, ship same day ordered
110	WVS, DTED, DFAD, etc.	Need correlation between databases

All reports of deficiency by DMA products are given in Tables 23 through 28, together with suggested improvements or requirements when these are not apparent. IDs are also included.

5.0 CONCLUSIONS

The M&S community has feature and attribute requirements that are currently not being met by emerging DMA vector products. Also, the accuracy and resolution requirements specified by the M&S community have not been met by existing DMA products.

Emerging DMA vector products do not currently contain (a) standard default symbology set(s). This presents the problems of standardization and usability for the Navy M&S community.

Many emerging DMA vector products have overlapping and redundant feature classes, features, and attributes.

A standard set of algorithms to convert applicable DMA two-dimensional databases to three-dimensional would be particularly useful to the M&S community and would allow the M&S community to maintain standardization once a DMA product is converted.

Incorporation of the recommendations contained in this report is considered necessary to ensure that the Navy M&S community is adequately represented with dMC&G and value-added data.

6.0 RECOMMENDATIONS

Produce a prototype value-added layer of OAML model output and databases in VPF coverage format. This prototype will combine the standard oceanographic model output and databases with emerging dMC&G vector products for improved exploitation.

Produce a prototype vector database for the M&S community that includes the required features and attributes identified in Sec. 2.0. Area of coverage should be the Norfolk littoral warfare test area, and distribution should be via CD-ROM.

Include the value-added feature/attribute information on IR and NVG signatures of key features and targets (to be identified, if approved, by NTSC) in the recommended prototype.

Perform a detailed analysis to alleviate the overlapping feature classes, features, and attributes that currently exist among VMap, ITD, UVMAP, DNC, WVS, DCW, DFAD, and DTED L2. If overlap is not alleviated, guidance must be given to the users for proper/optimum use of the correct product for a given feature class, feature, or attribute.

Correct the DMA product deficiencies/errors noted at the end of Sec. 4.0.

Develop a standard set of algorithms to convert appropriate existing DMA two-dimensional databases to three-dimensional.

Provide a standard symbology set with all emergent DMA vector products, e.g., DNC, ITD, VMap, and UVMAP. Such standardization will ensure that the commonality of vector products is maintained by all contractor and government developers to the end computer display. The symbology set must be an integral part of each emergent vector product specification.

Incorporate the accuracy and resolution requirements specified in Sec. 3.0 into the emerging vector products DNC, VMap, UVMAP, and ITD.

Improve the mechanics and speed of obtaining dMC&G products (emphasis on digital, not hardcopy, maps) from the Combat Support Center.

Produce a sampler CD-ROM with an updated *Digitizing the Future*, as well as expanded MUSE software for all DMA current and prototype vector products.

Publicize the fact that all imagery (classified and commercially available) should be obtained through DMA.

Develop and maintain a listing and brief description of all current and emergent DMA and NAVOCEANO products.

Integrate MSDB requirements into emerging shallow-water products.

Publish a DMA or Navy newsletter for emerging DMA products. This was requested by multiple Navy M&S programs.

Direct Navy M&S programs to use WGS84 as their horizontal datum.

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